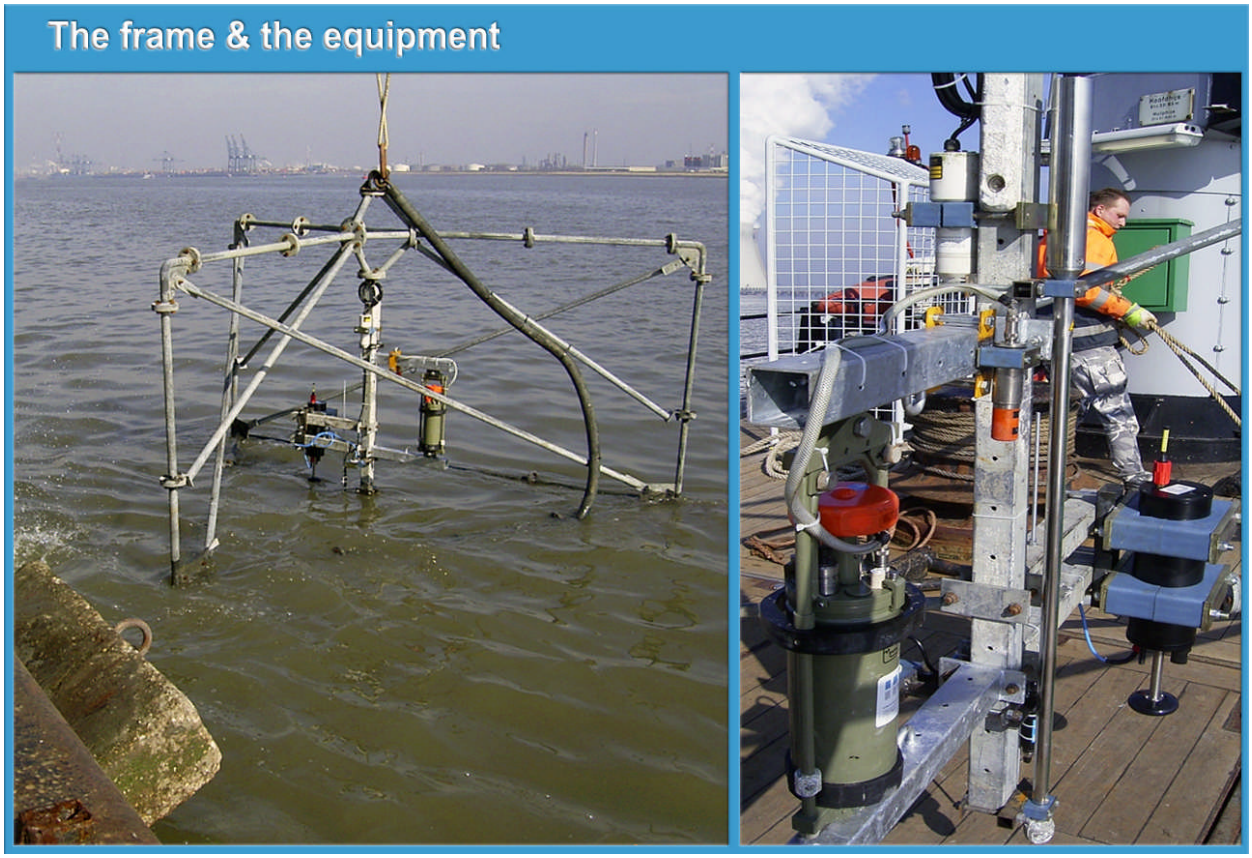
VLAAMSE OVERHEID

DEPARTEMENT MOBILITEIT EN OPENBARE WERKEN
WATERBOUWKUNDIG LABORATORIUM

Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing

Bestek 16EB/05/04



Deelrapport 2.16 : Zout – en slibverdeling Deurganckdok & frame metingen 21/06/2007 – 30/07/2007

Report 2.16: Salt – Silt distribution & frame measurements Deurganckdok 21/06/2007 – 30/07/2007

18 January 2008
I/RA/11283/07.092/MSA

i.s.m. &

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1. INTRODUCTION

1.1. The assignment

This report is part of the set of reports describing the results of the long-term measurements conducted in Deurganckdok aiming at the monitoring and analysis of silt accretion. This measurement campaign is an extension of the study "Extension of the study about density currents in the Beneden Zeeschelde" as part of the Long Term Vision for the Scheldt estuary. It is complementary to the study 'Field measurements high-concentration benthic suspensions (HCBS 2)'.

The terms of reference for this study were prepared by the 'Departement Mobiliteit en Openbare Werken van de Vlaamse Overheid, Afdeling Waterbouwkundig Laboratorium' (16EB/05/04). The repetition of this study was awarded to International Marine and Dredging Consultants NV in association with WL|Delft Hydraulics and Gems International on 10/01/2006. The project term was prolonged with an extra year from April 2007 till March 2008, 'Opvolging aanslibbing Deurganckdok'.

Waterbouwkundig Laboratorium– Cel Hydrometrie Schelde provided data on discharge, tide, salinity and turbidity along the river Scheldt and provided survey vessels for the long term and through tide measurements. Afdeling Maritieme Toegang provided maintenance dredging data. Agentschap voor Maritieme Dienstverlening en Kust – Afdeling Kust and Port of Antwerp provided depth sounding measurements.

The execution of the study involves a twofold assignment:

- Part 1: Setting up a sediment balance of Deurganckdok covering a period of one year, i.e. 04/2007 – 03/2008
- Part 2: An analysis of the parameters contributing to siltation in Deurganckdok

1.2. Purpose of the study

The Lower Sea Scheldt (Beneden Zeeschelde) is the stretch of the Scheldt estuary between the Belgium-Dutch border and Rupelmonde, where the entrance channels to the Antwerp sea locks are located. The navigation channel has a sandy bed, whereas the shallower areas (intertidal areas, mud flats, salt marshes) consist of sandy clay or even pure mud sometimes. This part of the Scheldt is characterized by large horizontal salinity gradients and the presence of a turbidity maximum with depth-averaged concentrations ranging from 50 to 500 mg/l at grain sizes of 60 - 100 μm. The salinity gradients generate significant density currents between the river and the entrance channels to the locks, causing large siltation rates. It is to be expected that in the near future also the Deurganckdok will suffer from such large siltation rates, which may double the amount of dredging material to be dumped in the Lower Sea Scheldt.

Results from the study may be interpreted by comparison with results from the HCBS and HCBS2 studies covering the whole Lower Sea Scheldt. These studies included through-tide measurement campaigns in the vicinity of Deurganckdok and long term measurements of turbidity and salinity in and near Deurganckdok.

The first part of the study focuses on obtaining a sediment balance of Deurganckdok. Aside from natural sedimentation, the sediment balance is influenced by the maintenance and capital dredging works. This involves sediment influx from capital dredging works in the Deurganckdok, and internal relocation and removal of sediment by maintenance dredging works. To compute a sediment balance an inventory of bathymetric data (depth soundings), density measurements of the

deposited material and detailed information of capital and maintenance dredging works will be made up.

The second part of the study is to gain insight in the mechanisms causing siltation in Deurganckdok, it is important to follow the evolution of the parameters involved, and this on a long and short term basis (long term & through-tide measurements). Previous research has shown the importance of water exchange at the entrance of Deurganckdok as essential for understanding sediment transport between the dock and the Scheldt river.

1.3. Overview of the Reports

Reports of the project 'Opvolging aanslibbing Deurganckdok 2' for the period April 2006 – March 2008 are summarized in Table 1-1.

Reports of the measurement campaign HCBS2 for which the winter and summer campaign has been carried out simultaneously with measurements in this report are listed in APPENDIX C.

Table 1-1: Overview of Deurganckdok Reports

Report	Description
Sediment Balance: Bathymetry surveys, Density measurements, Maintenance and construction dredging activities	
1.1	Sediment Balance: Three monthly report 1/4/2006 – 30/06/2006 (I/RA/11283/06.113/MSA)
1.2	Sediment Balance: Three monthly report 1/7/2006 – 30/09/2006 (I/RA/11283/06.114/MSA)
1.3	Sediment Balance: Three monthly report 1/10/2006 – 31/12/2006 (I/RA/11283/06.115/MSA)
1.4	Sediment Balance: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/06.116/MSA)
1.5	Annual Sediment Balance (I/RA/11283/06.117/MSA)
1.6	Sediment balance Bathymetry: 2005 – 3/2006 (I/RA/11283/06.118/MSA)
1.10	Sediment Balance: Three monthly report 1/4/2007 - 30/06/2007(I/RA/11283/07.081/MSA)
1.11	Sediment Balance: Two monthly report 1/7/2007 – 31/08/2007 (I/RA/11283/07.082/MSA)
1.12	Sediment Balance: Four monthly report 1/09/2007 – 31/12/2007 (I/RA/11283/07.083/MSA)
1.13	Sediment Balance: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/07.084/MSA)
1.14	Annual Sediment Balance (I/RA/11283/07.085/MSA)
Factors contributing to salt and sediment distribution in Deurganckdok: Salt-Silt (OBS3A) & Frame measurements, Through tide measurements (SiltProfiling & ADCP) & Calibrations	
2.1	Through tide measurement Siltprofiler 21/03/2006 Laure Marie

Report	Description
	(I/RA/11283/06.087/WGO)
2.2	Through tide measurement Siltprofiler 26/09/2006 Stream (I/RA/11283/06.068/MSA)
2.3	Through tide measurement Sediview spring tide 22/03/2006 Veremans (I/RA/11283/06.110/BDC)
2.4	Through tide measurement Sediview spring tide 27/09/2006 Parel 2 (I/RA/11283/06.119/MSA)
2.5	Through tide measurement Sediview neap tide (to be scheduled) (I/RA/11283/06.120/MSA)
2.6	Salinity-Silt distribution & Frame Measurements Deurganckdok 13/3/2006 – 31/05/2006 (I/RA/11283/06.121/MSA)
2.7	Salinity-Silt distribution & Frame Measurements Deurganckdok 15/07/2006 – 31/10/2006 (I/RA/11283/06.122/MSA)
2.8	Salinity-Silt distribution & Frame Measurements Deurganckdok 15/01/2007 – 15/03/2007 (I/RA/11283/06.123/MSA)
2.9	Calibration stationary equipment autumn (I/RA/11283/07.095/MSA)
2.10	Through tide measurement Siltprofiler winter (I/RA/11283/07.086/MSA)
2.11	Through tide measurement Salinity Profiling winter (I/RA/11283/07.087/MSA)
2.12	Through tide measurement Sediview winter (I/RA/11283/07.088/MSA)
2.13	Through tide measurement Sediview winter (I/RA/11283/07.089/MSA)
2.14	Through tide measurement Sediview winter (I/RA/11283/07.090/MSA)
2.15	Through tide measurement Siltprofiler (to be scheduled) (I/RA/11283/07.091/MSA)
2.16	Salt-Silt distribution Deurganckdok summer (21/6/2007 – 30/07/2007) (I/RA/11283/07.092/MSA)
2.17	Salt-Silt distribution & Frame Measurements Deurganckdok autumn (17/09/2007 - 10/12/2007) (I/RA/11283/07.093/MSA)
2.18	Salt-Silt distribution & Frame Measurements Deurganckdok winter (18/02/2008 - 31/3/2008) (I/RA/11283/07.094/MSA)
2.20	Calibration stationary & mobile equipment winter (I/RA/11283/07.096/MSA)
Boundary Conditions: Upriver Discharge, Salt concentration Scheldt, Bathymetric evolution in access channels, dredging activities in Lower Sea Scheldt and access channels	
3.1	Boundary conditions: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/06.127/MSA)
3.10	Boundary conditions: Three monthly report 1/4/2007 – 30/06/2007 (I/RA/11283/07.097/MSA)
3.11	Boundary conditions: Three monthly report 1/7/2007 – 30/09/2007 (I/RA/11283/07.098/MSA)
3.12	Boundary conditions: Three monthly report 1/10/2007 – 31/12/2007

Report	Description
	(I/RA/11283/07.099/MSA)
3.13	Boundary conditions: Three monthly report 1/1/2008 – 31/03/2008 (I/RA/11283/07.100/MSA)
3.14	Boundary conditions: Annual report (I/RA/11283/07.101/MSA)
Analysis	
4.1	Analysis of Siltation Processes and Factors (I/RA/11283/06.129/MSA)
4.10	Analysis of Siltation Processes and Factors (I/RA/11283/07.102/MSA)

1.3.1. Measurement actions

Following measurements have been carried out during the course of this project:

1. Monitoring upstream discharge in the Scheldt river
2. Monitoring Salt and sediment concentration in the Lower Sea Scheldt taken from on permanent data acquisition sites at Lillo, Oosterweel and up- and downstream of the Deurganckdok.
3. Long term measurement of salt distribution in Deurganckdok.
4. Long term measurement of sediment concentration in Deurganckdok
5. Monitoring near-bed processes in the central trench in the dock, near the entrance as well as near the landward end: near-bed turbidity, near-bed current velocity and bed elevation variations are measured from a fixed frame placed on the dock's bed.
6. Measurement of current, salt and sediment transport at the entrance of Deurganckdok for which ADCP backscatter intensity over a full cross section are calibrated with the Sediview procedure and vertical sediment and salt profiles are recorded with the SiltProfiler equipment
7. Through tide measurements of vertical sediment concentration profiles -including near bed highly concentrated suspensions- with the SiltProfiler equipment. Executed over a grid of points near the entrance of Deurganckdok.
8. Monitoring dredging activities at entrance channels towards the Kallo, Zandvliet and Berendrecht locks
9. Monitoring dredging and dumping activities in the Lower Sea Scheldt

In situ calibrations were conducted on several dates to calibrate all turbidity and conductivity sensors (IMDC, 2006a & IMDC, 2007a).

1.4. Structure of this report

This report is the factual data report for one measurement campaign:

- Long term salt/silt measurements in the Deurganckdok

The first chapter comprises an introduction. The second chapter describes the project. Chapter 3 describes the measurement campaign, equipment and the course of the actual measurements. The measurement results and processed data are presented in Chapter 4, whereas chapter 5 gives a preliminary analysis of the data.

2. SEDIMENTATION IN DEURGANCKDOK

2.1. Project Area: Deurganckdok

Deurganckdok is a tidal dock situated at the left bank in the Lower Sea Scheldt, between Liefkenshoek and Doel. Deurganckdok has the following characteristics:

1. the dock has a total length of 2750 m and is 450 m wide at the Scheldt end and 400 m wide at the inward end of the dock
2. The bottom of Deurganckdok is provided at a depth of –17m TAW in the transition zones between the quay walls and the central trench and of –19m TAW in the central trench.
3. the quay walls reach up to +9m TAW

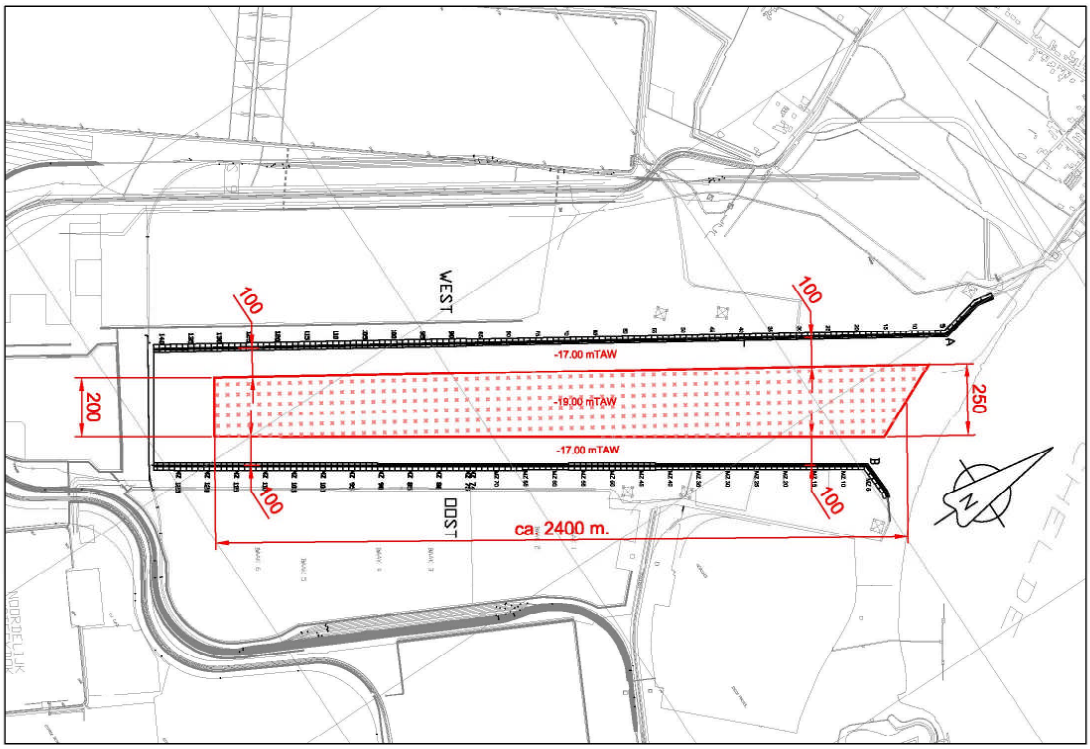

Figure 2-1: Overview of Deurganckdok

The dredging of the dock is performed in 3 phases. On 18 February 2005 the dike between the Scheldt and the Deurganckdok was breached. On 6 July 2005 Deurganckdok was officially opened. The second dredging phase was finalized a few weeks later. The first terminal operations have started since. In February 2007, the third dredging phase started and is planned to be finalised in 12 months time (by February 2008).

2.2. Overview of the studied parameters

The first part of the study aims at determining a sediment balance of Deurganckdok and the net influx of sediment. The sediment balance comprises a number of sediment transport modes:

deposition, influx from capital dredging works, internal replacement and removal of sediments due to maintenance dredging (Figure 2-2).

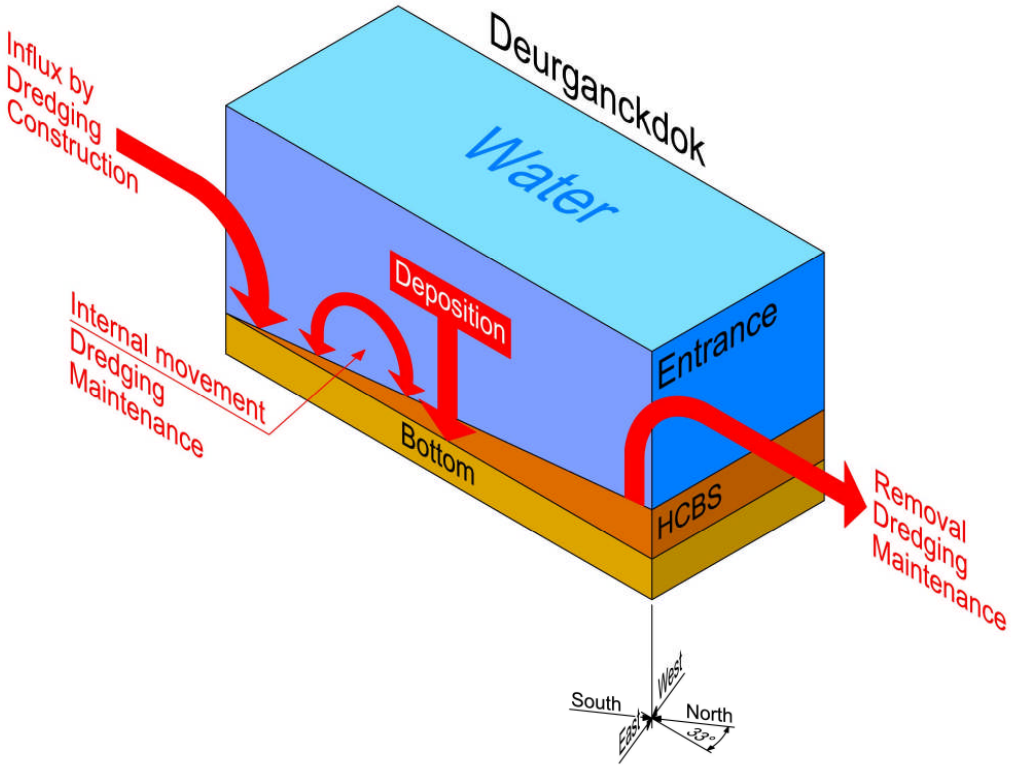

Figure 2-2: Elements of the sediment balance

A net deposition can be calculated from a comparison with a chosen initial condition t_0 (Figure 2-3). The mass of deposited sediment is determined from the integration of bed density profiles recorded at grid points covering the dock. Subtracting bed sediment mass at t_0 leads to the change in mass of sediments present in the dock (mass growth). Adding cumulated dry matter mass of dredged material removed since t_0 and subtracting any sediment influx due to capital dredging works leads to the total cumulated mass entered from the Scheldt river since t_0.

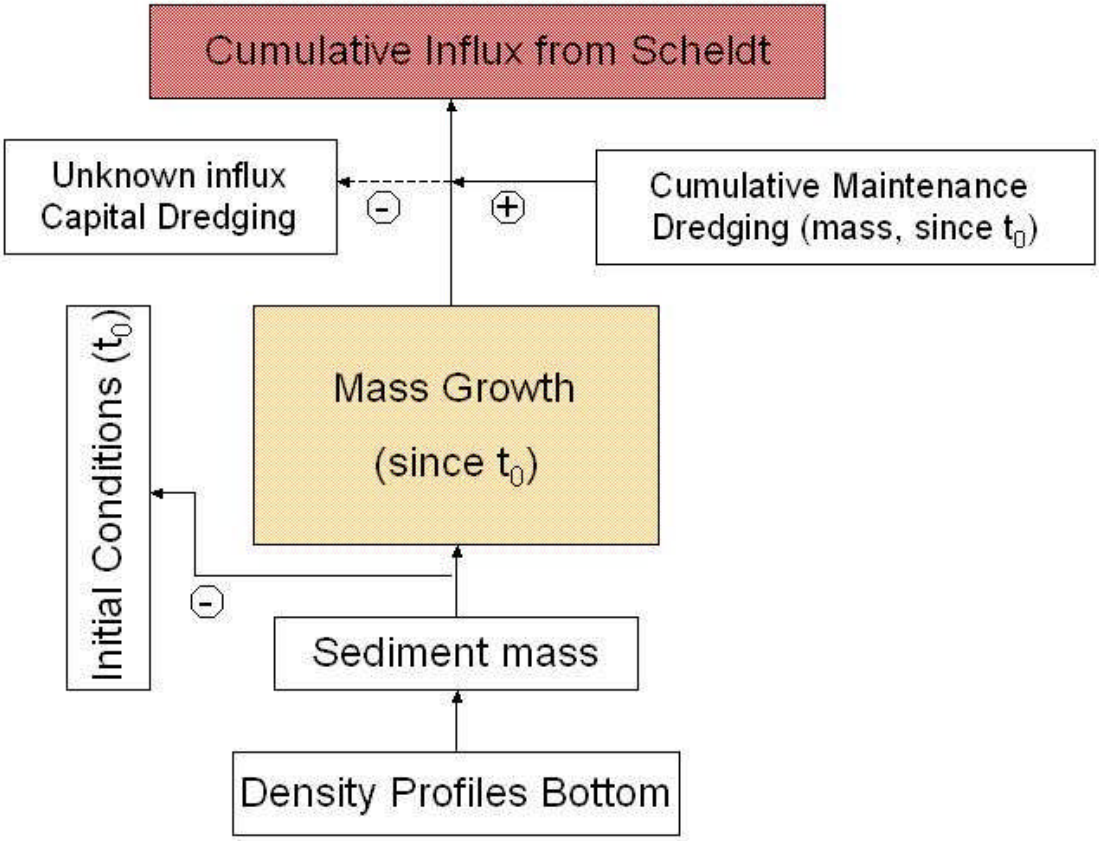

Figure 2-3: Determining a sediment balance

The main purpose of the second part of the study is to gain insight in the mechanisms causing siltation in Deurganckdok. The following mechanisms will be aimed at in this part of the study:

- Tidal prism, i.e. the extra volume in a water body due to high tide
- Vortex patterns due to passing tidal current
- Density currents due to salt gradient between the Scheldt river and the dock
- Density currents due to highly concentrated benthic suspensions

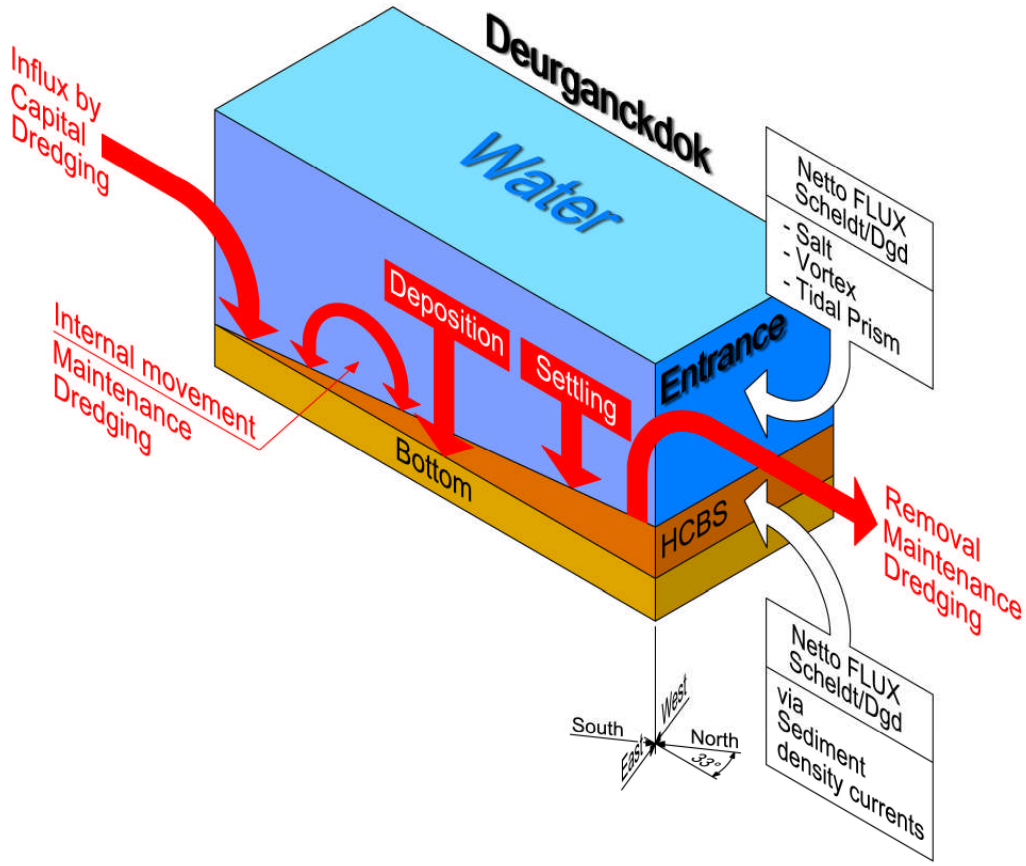

Figure 2-4: Transport mechanisms

These aspects of hydrodynamics and sediment transport have been landmark in determining the parameters to be measured during the project. Measurements will be focused on three types of timescales: one tidal cycle, one neap-spring cycle and seasonal variation within one year.

Following data are being collected to understand these mechanisms:

- Monitoring upstream discharge in the Scheldt river.
- Monitoring Salt and sediment concentration in the Lower Sea Scheldt at permanent measurement locations at Oosterweel, up- and downstream of the Deurganckdok.
- Long term measurement of salt and suspended sediment distribution in Deurganckdok.
- Monitoring near-bed processes (current velocity, turbidity, and bed elevation variations) in the central trench in the dock, near the entrance as well as near the current deflecting wall location.
- Dynamic measurements of current, salt and sediment transport at the entrance of Deurganckdok.
- Through tide measurements of vertical sediment concentration profiles -including near bed high concentrated benthic suspensions.
- Monitoring dredging activities at entrance channels towards the Kallo, Zandvliet and Berendrecht locks as well as dredging and dumping activities in the Lower Sea Scheldt.
- In situ calibrations were conducted on several dates to calibrate all turbidity and conductivity sensors.

2.3. Measurement objectives

The goal of the survey is to monitor the spatial distribution of salt and silt in the Deurganckdok. Longitudinal, vertical and horizontal (from north to south quay) distribution is surveyed in this set up. The entrance of the dock is a favoured location because of the dynamics caused by the river-dock interaction. One deeper location in the dock is necessary to sample the longitudinal distribution of salt and silt along the dock.

3. THE MEASUREMENT CAMPAIGN

3.1. Description of the long term suspended sediment-salinity measurements 21/06/2007 – 30/07/2007

3.1.1. Measurement location

During the period from 21/06/2007 till 30/07/2007, 6 multi parameter probes were placed on 3 fixed locations hanging from the quay wall in Deurganckdok at fixed depths.

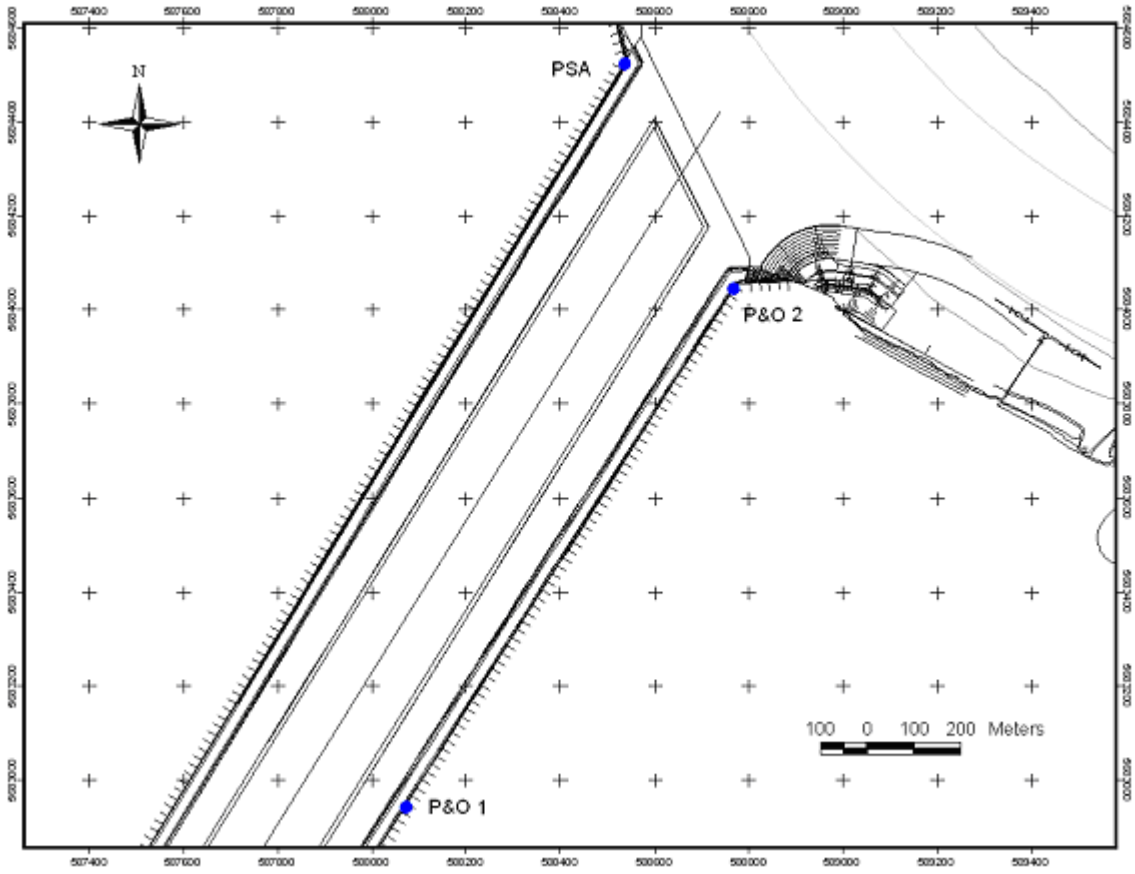

Figure 3-1: Map of the measurement locations for long term salt-silt measurements in Deurganckdok

Table 3-1: Measurement locations in UTM ED50

Location	***EASTING***	***NORTHING***	***Boulder***	***Operator***
P&O 1 (S-back)	588074	5682942	Moot 72	P&O Ports
P&O 2 (S-entrance)	588767	5684045	Moot 7	P&O Ports
PSA (N-entrance)	588536	5684523	Moot 5 (boulder 286)	PSA HNN

Table 3-2: Deployment depths of all instruments for the measurement period

Salt Silt Measurements Deurganckdok				
Location	Easting (UTM ED 50)	Northing (UTM ED 50)	Depth of instrument [m TAW]	Period
P&O 1 top	588074	5682942	-2.5	20/06/2007 – 30/07/2007
P&O 1 bottom	588074	5682942	-12.1	20/06/2007 – 30/07/2007
P&O 2 top	588767	5684045	-2.5	20/06/2007 – 31/07/2007
P&O 2 bottom	588767	5684045	-13.5	20/06/2007 – 31/07/2007
PSA top	588536	5684523	-2.1	20/06/2007 – 30/07/2007
PSA bottom	588536	5684523	-11.5	20/06/2007 – 30/07/2007

3.1.2. The equipment

3.1.2.1. Quay Frame set up

A simple rectangular measurement frame was conceived for suspending the instruments from the quay wall down into the Deurganckdok. Two frames rest against the dock wall and are suspended by stainless steel cables hanging from a rawlplug, secured on top of the quay wall.

Using a guiding system and a winch, it was possible to recover these instruments without the help of a survey vessel.

Figure 3-2: Guiding system and chain suspended from the rawlplug (left), frame with RCM-9 and steel cables (right)

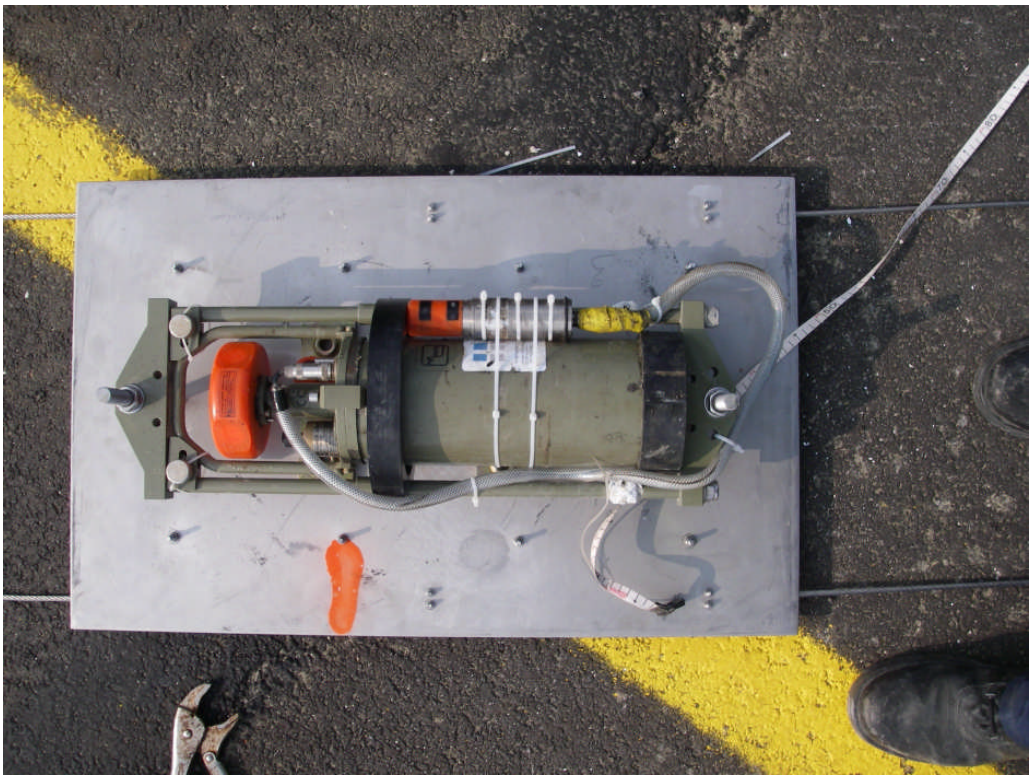

Figure 3-3: frame design

3.1.2.2. Aanderaa RCM-9

The Aanderaa Recording Current Meter RCM-9 MkII is a multi-parameter instrument that consists of a CTD probe, Doppler Current Sensors and a Turbidity Sensor. It was set up to measure an average of a number of pings spread over an interval of 10 minutes for conductivity, depth, temperature and turbidity.

IMDC (2006a) gives more technical details on the RCM-9.

3.1.2.3. D& A Instruments OBS 3A

The D & A Instruments OBS 3A is a multiparameter instruments that consists of a CTD probe and a turbidity sensor. The instrument was set up to measure every ten minutes for a minute at a frequency of 1 Hz and output the average.

IMDC (2006a) gives more technical details on the OBS 3A.

3.1.3. Course of the measurements

After deployment on 20/06/2007, the instruments were recovered, cleaned and read out approximately every two weeks. Table 3-3 lists the measurement periods and possible issues. Only OBS 3A instruments were deployed during this measurement period

Table 3-3: Overview of measurement periods and data gaps

P&O1 (S-BACK): -12.1 m TAW			
Period	No data	Faulty data	Comments
20-21/06/2007		X	Start measurement period: transition data
3-4/07/2007	X		Gaps in data
30/07/2007			End measurement period
P&O1 (S-BACK): -2.5 m TAW			
Period	No data	Faulty data	Comments
20-21/06/2007		X	Start measurement period: transition data
30/07/2007			End measurement period
P&O 2 (S-ENTRANCE): -13.5 m TAW			
Period	No data	Faulty data	Comments
20-21/06/2007		X	Start measurement period: transition data
26/06/2007	X		Gap in data
4-6/07/2007	X		Erroneous data
15/07/2007	X		Gap in data
17/07/2007		X	Erroneous data
31/07/2007			End measurement period
P&O 2 (S-ENTRANCE): -2.5 m TAW			
Period	No data	Faulty data	Comments
20-21/06/2007		X	Start measurement period: transition data
6/07/2007	X		Erroneous date
31/07/2007			End measurement period
PSA (N-ENTRANCE): -11.5 m TAW			
Period	No data	Faulty data	Comments
20-21/06/2007		X	Start measurement period: transition data
23/06/2007	X		Gaps in data
30/07/2007			End measurement period
PSA (N-ENTRANCE): -2.1 m TAW			
Period	No data	Faulty data	Comments
20-21/06/2007		X	Start measurement period: transition data
30/07/2007			End measurement period

4. PROCESSING OF DATASETS

4.1. Calibration of the sensors

A crucial aspect of the accuracy and reliability of the data concerns the calibration of the instruments. The calibration procedures and results are described in report 2.9: Summer calibration of the HCBS2 measurements (IMDC, 2007m).

4.2. Long term measurements near quay wall

A second period of the long term measurements executed at two depths (approximately -2.4 m TAW and -12.4 m TAW) at three locations on the quay walls of Deurganckdok lasted from 20 June until 30 July 2007. Depth, temperature, salinity and suspended sediment concentration have been logged. All gathered time series have been converted to appropriate engineering units and combined to form series covering the complete period. During validation erroneous data due to mid term recovery, sensor malfunction and buried equipment has been removed. In this form the data is ready for processing.

4.2.1. Factual data: Weekseries

Measurements are visualized per instrument, location and per week in APPENDIX B.

- The title shows the week number followed by the year
- The second graph depicts the salinity and temperature
- The third and last graph shows the water level at the nearest tidal gauge and the suspended sediment concentration

Faulty data is omitted from these graphs.

4.2.2. Average tidal cycle of local parameters

For all parameters measured at one location data has been organised in separate series per tidal cycle (low water to next low water). High water moments were placed on a fixed position in the series, low water moments differ in time relative to high water due to variation in flood and ebb length with neap-spring phases. In this way a time series with time relative to high water is produced for each tide. When tidal elevation data showed substantial gaps data from pressure gauges was used to divide the long series into tidal series.

By defining average tidal amplitude A for neap, average and spring tides, it becomes possible to classify tidal cycles in three categories in the following way:

$$Neap : A \le \alpha(A_{neap} + A_{aver})$$
$$Spring : A \ge \alpha(A_{spring} + A_{aver})$$
$$Average : \alpha(A_{neap} + A_{aver}) < A < \alpha(A_{spring} + A_{aver})$$

where: A_{neap} , A_{aver} and A_{spring} are average amplitudes

α is a factor to decide where to distinguish between categories (here taken as 0.5)

Using such categorisation the tidal series can be grouped in neap, average and spring tides. Within these groups an average is made per parameter per tidal phase relative to high water (Figure 4-1). In this way an average neap tidal cycle, an average middle tidal cycle and an average spring tidal cycle is obtained for all parameters.

The same exercise is repeated for relative values, which are the measured values divided by the tidal average (the average parameter value for that particular tidal cycle). All three types are shown in one plot with a plot for salinity, sediment concentration and temperature per page in APPENDIX D1.

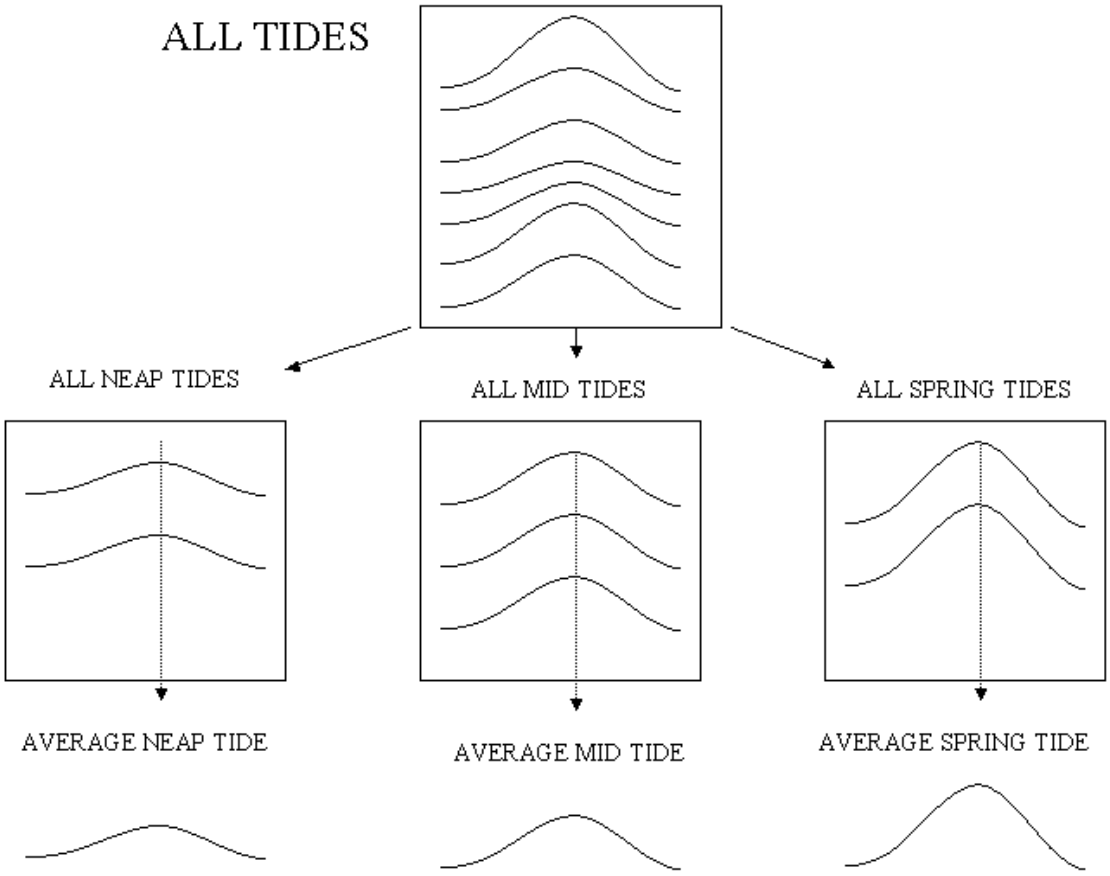

Figure 4-1: Categorisation of tidal tidal cycles

4.2.3. Average tidal cycle of gradients

For each of the three parameters being processed, four horizontal gradients (along dock's axis and cross dock, each at two depths) and three vertical gradients (one per location) have been calculated. The gradient along Deurganckdok was obtained by the difference of measurements between locations P&O2 (S-ENTRANCE) and P&O1 (S-BACK) (P&O1 minus P&O2), covering a distance of 1302.64 m. The gradient across Deurganckdok was calculated as the difference between locations P&O2 (S-ENTRANCE) and PSA (N-ENTRANCE) (PSA minus P&O2); the distance between these locations measured 530.89 m. For each of the locations a vertical gradient has been calculated from the difference between the measurements at –2.4 m TAW and the measurements at –12.4 m TAW (-12.2 m data minus –2.4 m data).

The time series of gradients obtained as such have then been processed following exactly the same tidal separation technique as for the local parameters (described in 4.2.2). The results are shown in APPENDIX D.1.

5. PRELIMINARY ANALYSIS

5.1. Long term salinity measurements 20/06/2007 – 30/07/2007

For each of the three locations salinity, sediment concentration and temperature have been logged at two depths. Apart from week series of every parameter, average tidal cycles have been determined for each parameter. This was done for absolute and relative values, as well as for horizontal gradients along and across the dock, and vertical gradients (APPENDIX D). All of these results are discussed below.

5.1.1. Week series

5.1.1.1. P&O 1 (S-BACK)

Salinity showed a tidal variation and measured between 13 and 18 ppt at the bottom of the dock and the beginning of the measurement campaign. It gradually decreased to a minimal value of approximately 13-14 ppt on 6 July and showed a minimal tidal variability. From 9 July on, this variation increased again. At the top of the water column, salinity is 1-2 ppt lower in comparison to the bottom's salinity. Also here, tidal variations are in the range of 2 ppt. Variations remain more significant in the period of 6-9 July in comparison to the bottom's observations.
The water temperature gradually decreased from approximately 22°C to 18-19°C in order to rise again by 14 July.
The near water surface suspended sediment concentration at the landside of the dock measured less than 50 mg/l. Occasional concentration peaks occurred with values up to 400 mg/l. A stronger burst can be seen on 27 July with suspended solids concentrations going up to 900 mg/l. Instead, bottom base concentrations were much larger. A base concentration was observed between 50 and 100 mg/l. Regular small bursts of suspended solids concentration were observed too and measured between 50 and 200 mg/l. Large peaks of up to 1000 mg/l were seen as well, which considerably exceeded the surface peak concentrations.

5.1.1.2. P&O 2 (S-ENTRANCE)

Measured salinities showed only slight tidal fluctuations near the bottom (-13.5 m TAW); the tidal variation was more pronounced near the water surface (-2.5 m TAW) though. During the measurement campaign the salinity gradually decreased from approximately 16-18 ppt (at 21-22 Juny) to 13 ppt, to slowly increase again on 12 July to a value of just below 15 ppt. Instead, water temperature decreased from 21-22°C to 18-19°C by 6-7 July. Afterwards, the temperature gradually increased again.
Near the top of the dock the suspended sediment concentration followed the tidal variation. Due to many bursts of solids concentration, this trend cannot be clearly observed near the bottom of the water column. The near water surface suspended sediment concentration at the landside of the dock measured less than 50 mg/l. Again, bottom base concentrations were much larger. A base concentration was observed between 50 and 100 mg/l. Regular small bursts suspended solids concentration were observed too and measured between 50 and 200 mg/l.

5.1.1.3. PSA (N-ENTRANCE)

Near the bottom, salinity measured around 17 ppt, which gradually dropped to a value of approximately 13 ppt on 8 July, and subsequently increased again to a value of 15 ppt. A second decrease to 13 ppt occurred on 26 July. Minima of salinity were observed at low tide of every tidal cycle. Near the water surface (at -2.3 m TAW) salinity showed a more pronounced tidal behaviour.
The water temperature gradually decreased from approximately 22°C to 19°C in order to rise again

after July 15.
The time series of bottom suspended sediment concentration was generally characterised by peak values between 300 and 800 mg/l during flood. The base sediment concentration was around 50 mg/l though. Note also that the sediment concentration peaks were much less pronounced near the water surface and showed values of only up to 200 mg/l SSC. The tidal behaviour was almost absent.

5.1.2. Average tidal cycles

Plots of averaged tidal cycles can be found in APPENDIX D.

5.1.2.1. Local Parameters

The water temperature was rather constant for the different averaged tidal cycles (neap, average and spring tide) and measured slightly below 20°C for an average tide. At neap and spring tides, temperatures were above 20°C.

Salinity showed small values in the range of 12-16 ppt. At PSA (N-ENTRANCE), a maximum salinity occurred 1-2 hours after flood tide. A more than proportional decrease was observed at ebb tide. It all remains a relatively weak tidal effect though. At the other two measurement locations, P&O2 (S-ENTRANCE) and P&O1 (S-BACK), hardly any variation in salinity was observed.

In comparison with salinity and temperature, suspended sediment concentration showed the largest variation over an average tidal cycle. The plots in APPENDIX D clearly indicate the occurrence of a concentration peak at the dock entrance at 0-2 hours after flood tide. Obviously, the largest concentration could be observed at spring tide. Whereas the bottom peak concentration measured 3x and 2x the base concentration for the PSA (N-ENTRANCE) and P&O2 (S-ENTRANCE) locations respectively, tidal concentration variations at the top of the water column were negligible. During neap tide, a top concentration peak occurred 1-2 hours prior to flood tide at P&O2 (S-ENTRANCE) though. This peak near the water surface was also observed at P&O1 (S-BACK).

5.1.2.2. Gradients

Cross-dock gradients from P&O 2 (S-ENTRANCE) towards PSA (N-ENTRANCE) have been calculated at both –2.2 m TAW and –12 m TAW. In general, calculated gradients were low and close to zero. The gradients showed a similar behaviour for the different considered tides. The cross-section gradient of salinity near the bottom of the dock was negative between 3 and 7 hours after flood tide, indicating that the salt concentration was largest near the southern quay. The largest positive gradients occurred 1-2 hours after flood tide. Instead, positive gradients were observed for the suspended sediment concentration throughout the tidal cycle. Also here, a maximum gradient was observed 1 hour after flood tide.
Closer to the water surface at the dock entrance, observed gradients showed the same order of magnitude. Note that the salinity gradient was only positive between flood tide and three hours after it.

Along-dock gradients run from the entrance towards the inland end of the dock. From the observations it is clear that salinity and temperature gradients were negligible both at the bottom and the surface. Near the surface, salinity gradients were negative for a period of 6 hours around flood tide. Near the bottom, gradients were always larger than zero, i.e. the salinity at the back-end of the dock was larger than at the entrance.
From the measurements, it was seen that the bottom suspended sediment concentration gradient was positive for the entire tidal cycle, except for two hours around flood time at the bottom and three hours prior to flood time near the surface. At neap tide, positive gradients occurred though. In

other words, the sediment concentration near the surface of the dock was larger near the entrance in comparison to the inland side of the dock for both an average and spring tide.

Vertical gradients were very small for temperature. Salinity gradients remained positive throughout the tidal cycle indicating that the salinity is larger near the bottom compared to locations near the water surface. Clearly, the largest gradients occurred 3-4 hours prior to high water near the entrance of the dock. Instead, the back-end of the dock showed the largest gradients 3-4 hours after flood tide. These observations are obviously the result of salt intrusion and extrusion effects. The suspended sediment concentrations were largest at the bottom of the northern entrance, with a peak value around flood tide. At PSA (N-ENTRANCE) vertical sediment concentration gradients measured up to 2 mg/l/m at average and spring tide, whereas P&O1 (S-ENTRANCE) was characterised with values of up to approximately 0.7 mg/l/m. Inside the dock, positive sediment concentration gradients prevailed and measured up to 1.3 mg/l/m.

5.1.3. Comparison with previous measurements

In comparison to the previous summer measurement campaign (see IMDC (2007i), Appendices), the range of suspended sediment concentrations is similar. The salinity range is significantly larger than the one observed during the winter 2007 campaign (see IMDC (2007j), Appendices). Instead, it is more comparable to the salinities observed in the summer of 2006 (range of 18-21 ppt). Temperature variability is comparable to both spring and summer 2006 campaigns; its range is similar to summer 2006, but a couple of degrees lower.

With respect to the averaged tidal cycles, it seems that most phenomena from this campaign correspond to previous measurements. Compared to the summer 2006 observations:

- suspended solids concentration variation shows a less pronounced effect at spring tide at the bottom of N-ENTRANCE;
- the peaks of suspended solids concentration at S-BACK do not coincide for the different tides; and
- an extreme peak of suspended solids concentration exists at neap tide for the top locations S-BACK en S-ENTRANCE.

With respect to the parameter gradients, both the magnitude and the tidal variation of the gradients are very similar to the observations performed in the summer of 2006. Many similarities can be seen between the different measurement campaigns. It was also observed that during the winter 2007 measurements a more pronounced near-surface suspended sediment concentration peak occurred at spring tide at the north of the dock entrance, i.e. larger concentrations prevailed at PSA (N-ENTRANCE) in comparison with P&O2 (S-ENTRANCE). Along the dock, a larger negative sediment concentration gradient was observed in comparison with the present campaign; hence, the concentration change along the dock is less significant in the present case.
With respect to the vertical gradients, salinity and temperature gradients all have a similar range of observed values.

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APPENDIX A.

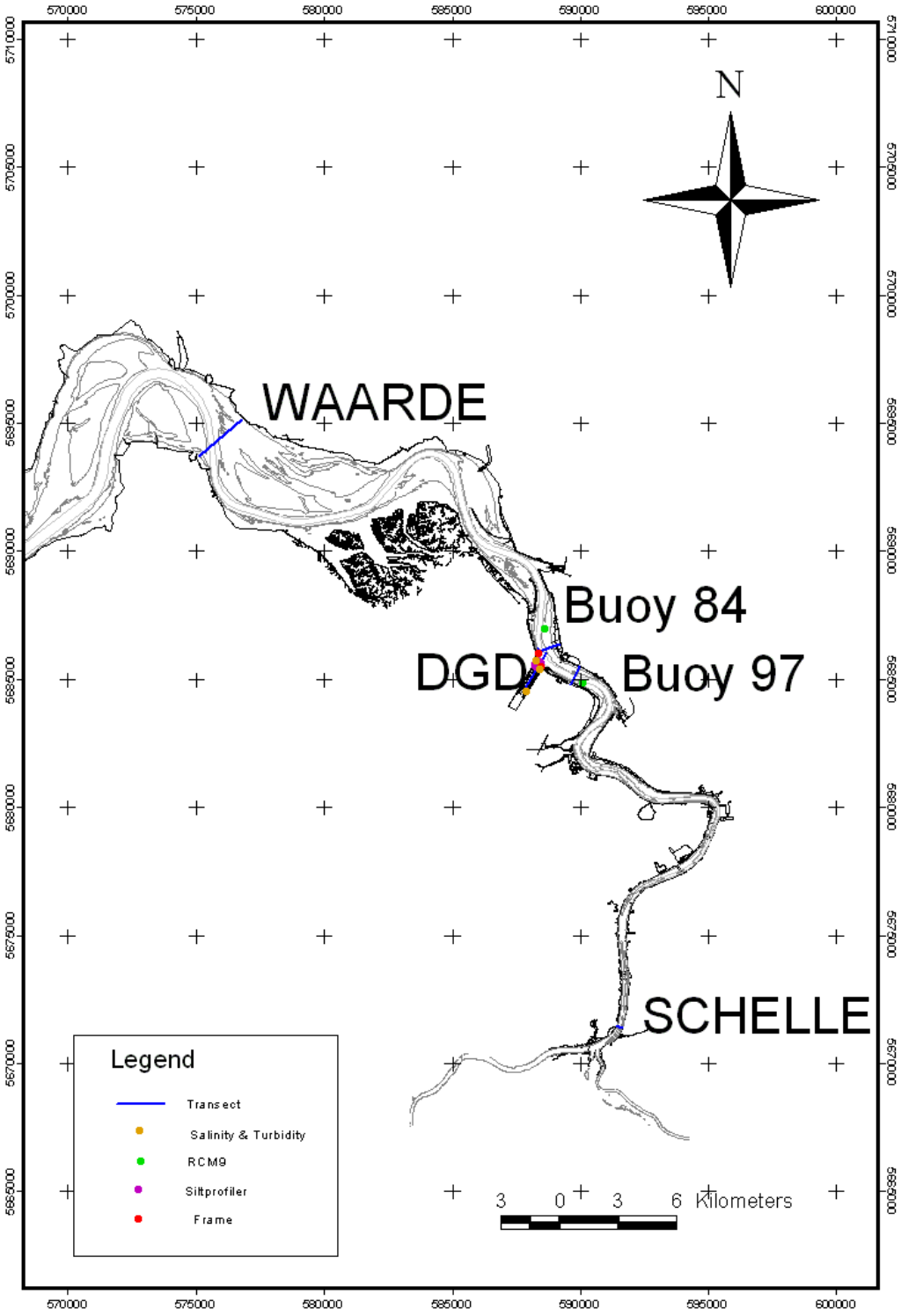
OVERVIEW OF MEASUREMENTS

A.1 Overview of the measurement locations for the whole HCBS 2 measurement campaign & DGD measurement campaign

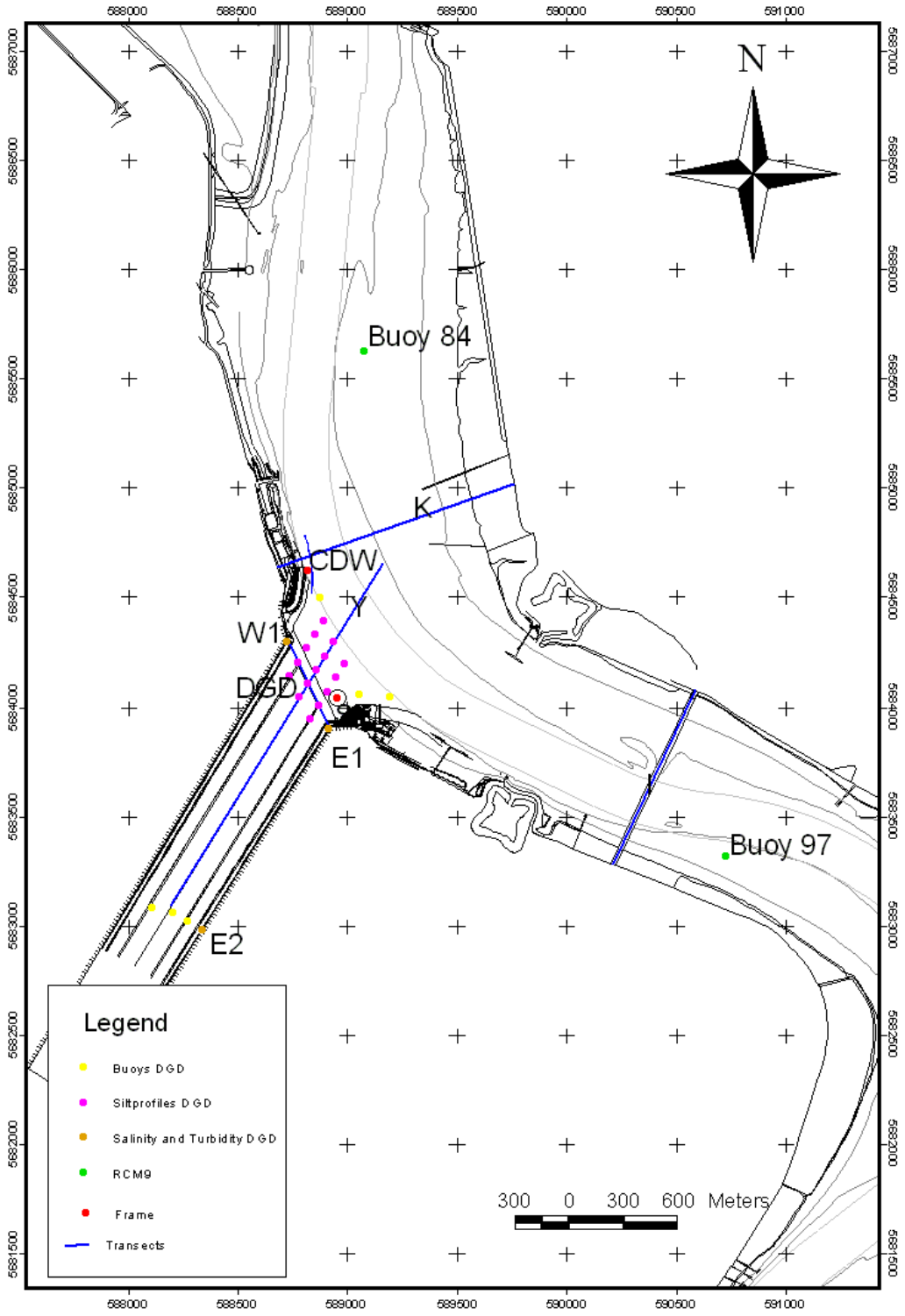
Through tide measurements: Transects					
Location	*Easting (UTM ED 50)*		*Northing (UTM ED 50)*		*Period*
Deurganckdok (in dock)	Left Bank	Right Bank	Left Bank	Right Bank	21/03/2006 & 26/09/2006 & 24/10/2007
(transect Y)	589059	591298	5684948	5683077	
Liefkenshoek	Left Bank	Right Bank	Left Bank	Right Bank	21/03/2006 & 26/09/2006 & 24/10/2007
(transect I)	590318	590771	5684257	5683302	
Deurganckdok (downstream)	Left Bank	Right Bank	Left Bank	Right Bank	22 & 23/03/2006 & 27 & 28/09/2006 & 24/10/2007
(transect K)	588484	589775	5684924	5685384	
Deurganckdok (in dock)	Left Bank	Right Bank	Left Bank	Right Bank	22/03/2006 & 27/09/2006 & 24/10/2007
(transect DGD)	588765	588541	5684056	5684527	
Schelle	Left Bank	Right Bank	Left Bank	Right Bank	23/03/2006 & 28/09/2006 & 24/10/2007
(transect S)	592645	592953	5665794	5665682	
Waarde	Left Bank	Right Bank	Left Bank	Right Bank	23/03/2006 & 28/09/2006 & 24/10/2007
(transect W)	573541	571318	5696848	5694933	
Through tide measurements: Siltprofiler gauging points					
Location	*Easting (UTM ED 50)*		*Northing (UTM ED 50)*		*Period*
Location 1: Xa	588549		5684335		21/03/2006 & 26/09/2006 & 24/10/2007
Location 2: Xb	588596		5684411		
Location 3: Xc	588643		5684486		
Location 4: Xd	588690		5684562		
Location 5: Xe	588737		5684638		
Location 6: Ya	588606		5684217		
Location 7: Yb	588653		5684293		
Location 8: Yc	588700		5684368		

Through tide measurements: Siltprofiler gauging points			
Location	*Easting (UTM ED 50)*	*Northing (UTM ED 50)*	*Period*
Location 9: Yd	588747	5684444	21/03/2006 & 26/09/2006 & 24/10/2007
Location 10: Ye	588793	5684520	
Location 11: Za	588662	5684099	
Location 12: Zb	588709	5684174	
Location 13: Zc	588756	5684250	
Location 14: Zd	588803	5684326	
Location 15: Ze	588850	5684402	
Near bed continuous monitoring			
Location	*Easting (UTM ED 50)*	*Northing (UTM ED 50)*	*Period*
Deurganckdok CDW	588653	5684906	14/03/2006 – 05/04/2006
Deurganckdok CDW	588685	5684880	19/04/2006 – 23/05/2006
Deurganckdok Sill	588805	5684170	19/04/2006 – 23/05/2006
Deurganckdok CDW	588685	5684880	18/07/2006 – 11/10/2006
Deurganckdok Sill	588805	5684170	19/07/2006 – 11/10/2006
Deurganckdok CDW	588685	5684880	15/03/2007 – 12/04/2007
Deurganckdok Sill	588805	5684170	09/02/2007 – 18/04/2007
Salt Silt measurements Deurganckdok			
Location	*Easting (UTM ED 50)*	*Northing (UTM ED 50)*	*Period*
P&O 1	588074	5682942	17/03/2006 – 28/04/2006
P&O 2	588767	5684045	17/03/2006 – 28/04/2006
PSA	588536	5684523	17/03/2006 – 28/04/2006
P&O 1	588074	5682942	20/07/2006 – 12/10/2006
P&O 2	588767	5684045	20/07/2006 – 12/10/2006
PSA	588536	5684523	20/07/2006 – 12/10/2006

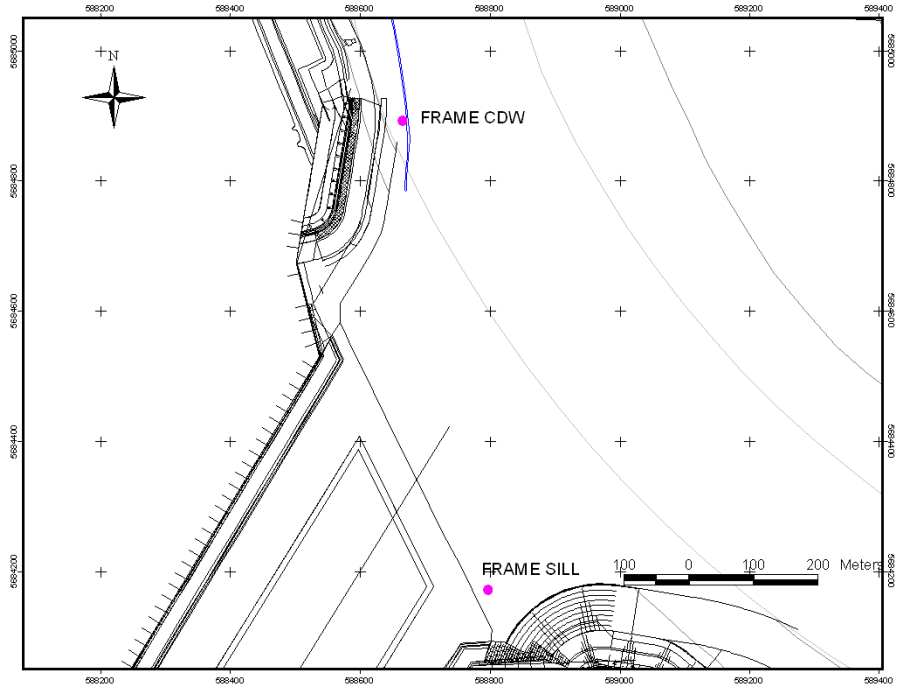
Salt Silt measurements Deurganckdok			
Location	*Easting (UTM ED 50)*	*Northing (UTM ED 50)*	*Period*
P&O 1	588074	5682942	12/02/2007 – 27/03/2006
P&O 2	588767	5684045	12/02/2007 – 27/03/2006
PSA	588536	5684523	12/02/2007 – 27/03/2006
P&O 1	588074	5682942	20/06/2007 – 30/07/2007
P&O 2	588767	5684045	20/06/2007 – 31/07/2007
PSA	588536	5684523	20/06/2007 – 30/07/2007
Settling velocity – INSSEV			
Location	*Easting (UTM ED 50)*	*Northing (UTM ED 50)*	*Period*
Deurganckdok CDW	588717	5684898	05/09/2006
Deurganckdok SILL	588800	5684250	06/09/2006
Deurganckdok Western quay wall	588452	5684355	07/09/2006



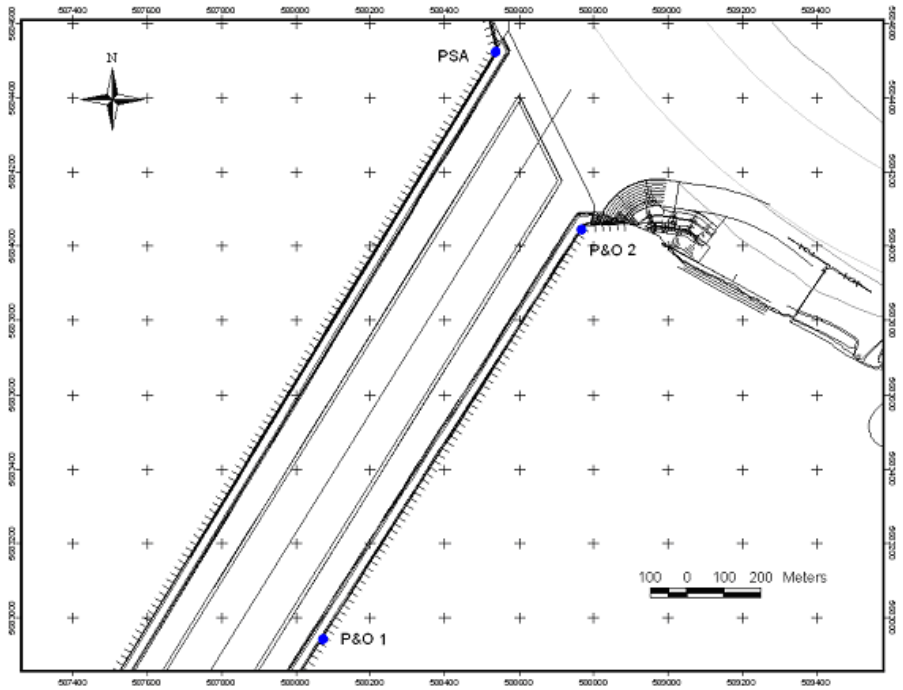
Overview of the measurement locations
21/03/2006 – 23/03/2006 & 26/09/2006 – 28/09/2006



Overview of the measurement locations in Deurganckdok

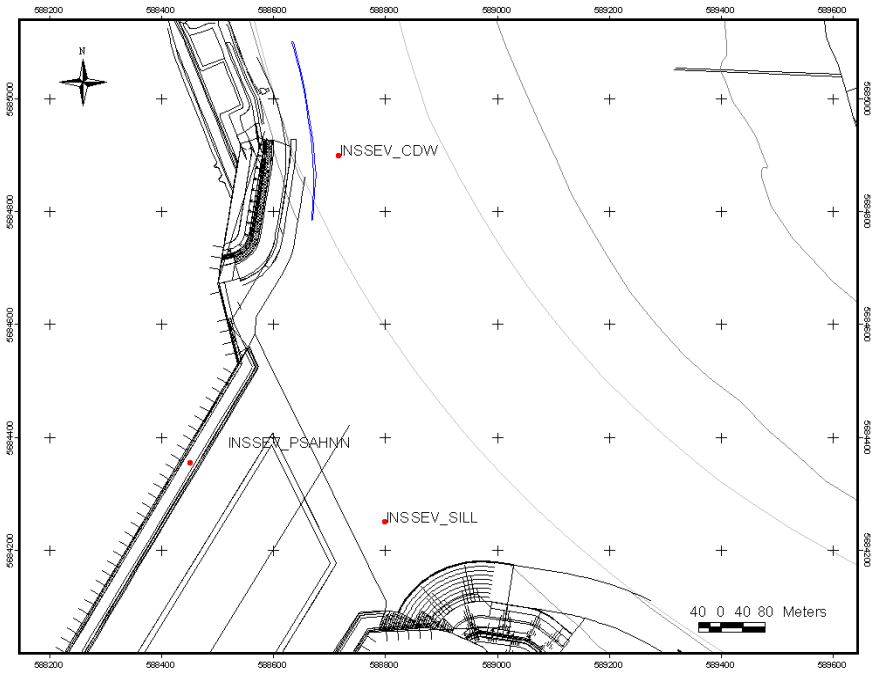


Near bed continuous monitoring
14/03/2006 – 05/04/2006 & 19/04/2006 – 23/05/2006 & 18/07/2006 – 11/10/2006 & 09/02/2007 – 18/04/2007

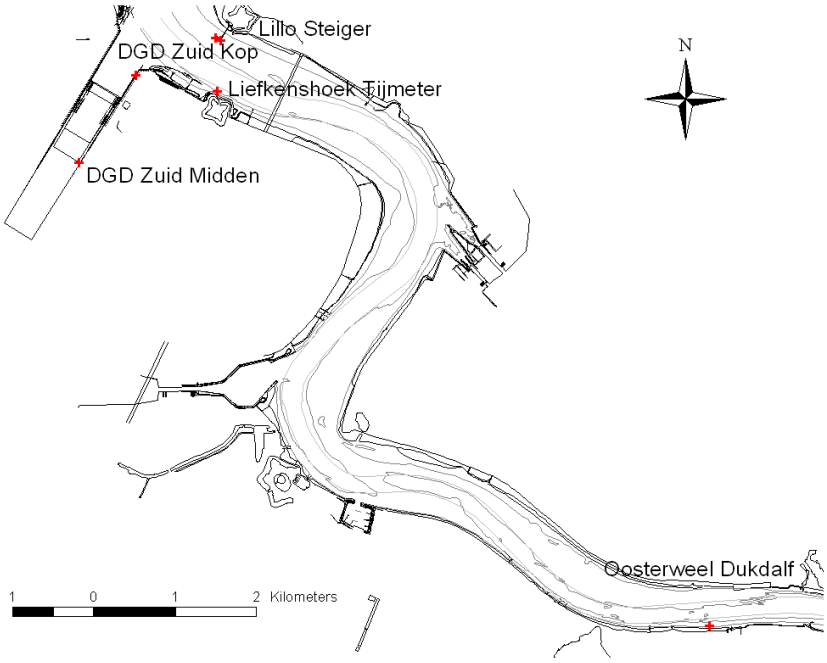


Long term salt-silt measurements in Deurganckdok
17/03/2006 – 28/04/2006 & 20/07/2006 – 12/10/2006 & 12/02/2007 – 27/03/2007 & 20/06/2007 –

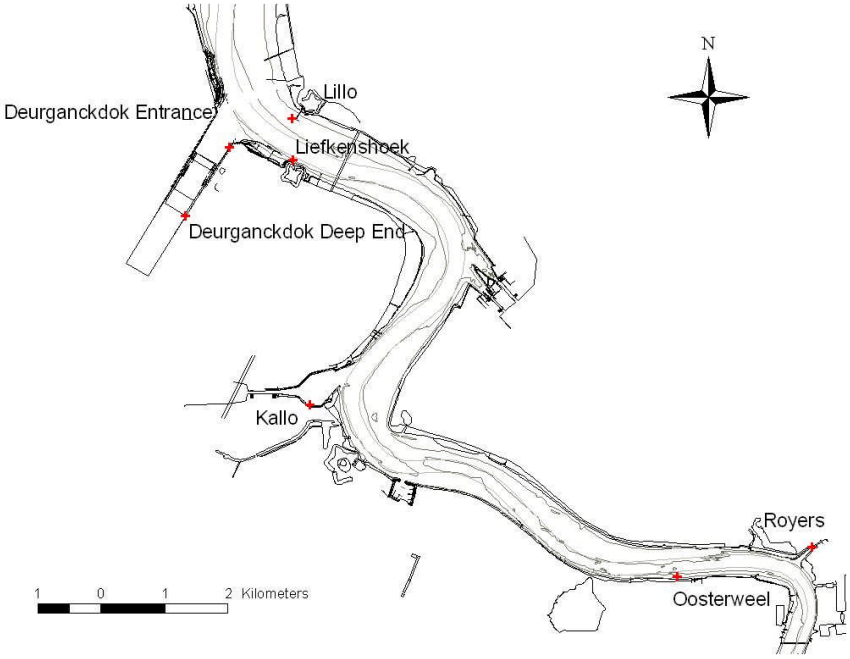
31/07/2007



Settling velocity (INSSEV) 05/09/2006 – 07/09/2006



Calibration measurements - 15/03/2006 & 14/04/2006



Calibration measurements - 23/06/2006 & 18/09/2006

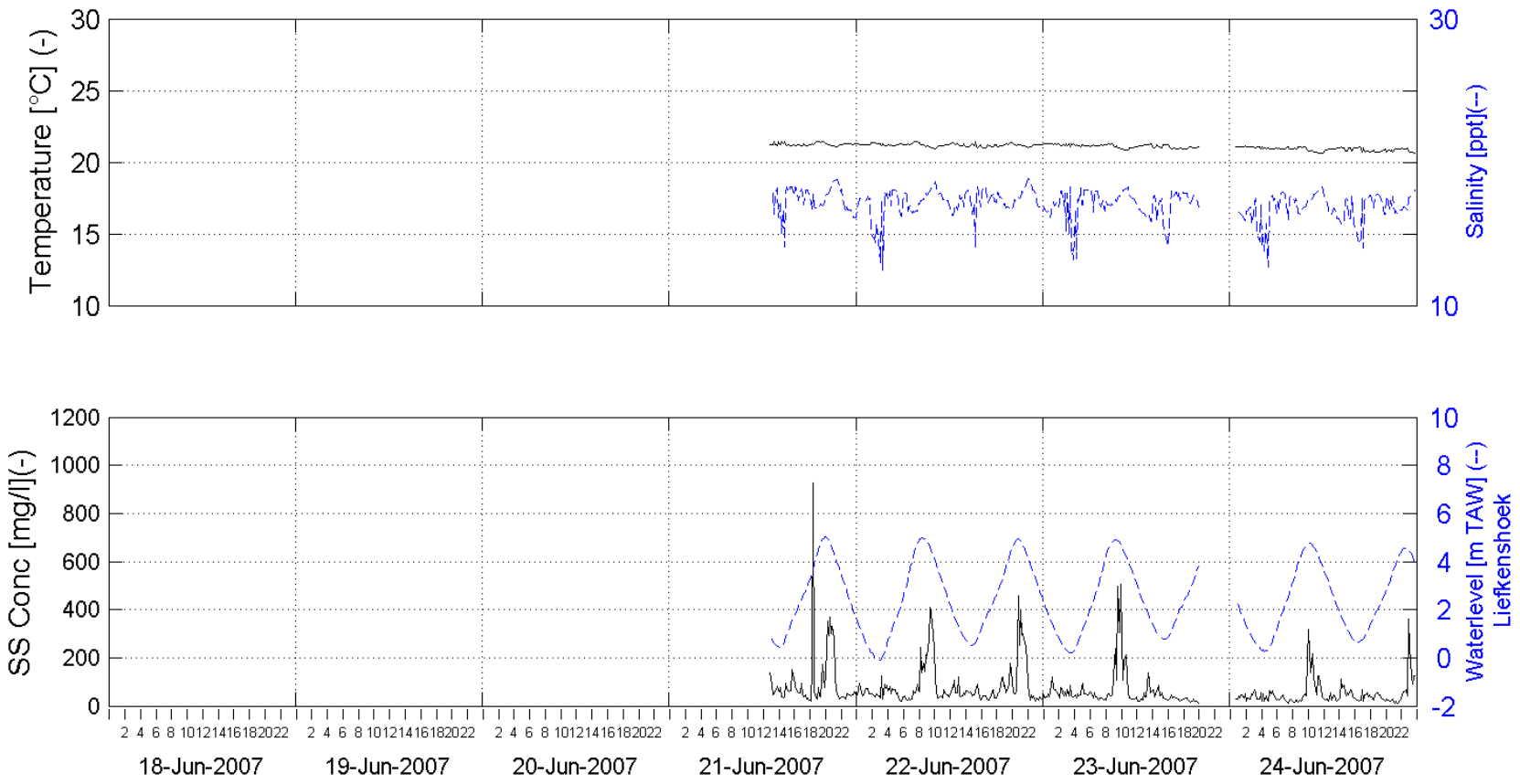
APPENDIX B.

WEEKSERIES ZOUT- SLIB METINGEN DGD

B.1 PSA (N-ENTRANCE)

11283 - Long-term monitoring DGD - Summer 2007

Week 25 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 5.5m above bottom (-11.5m TAW)

Processed by:

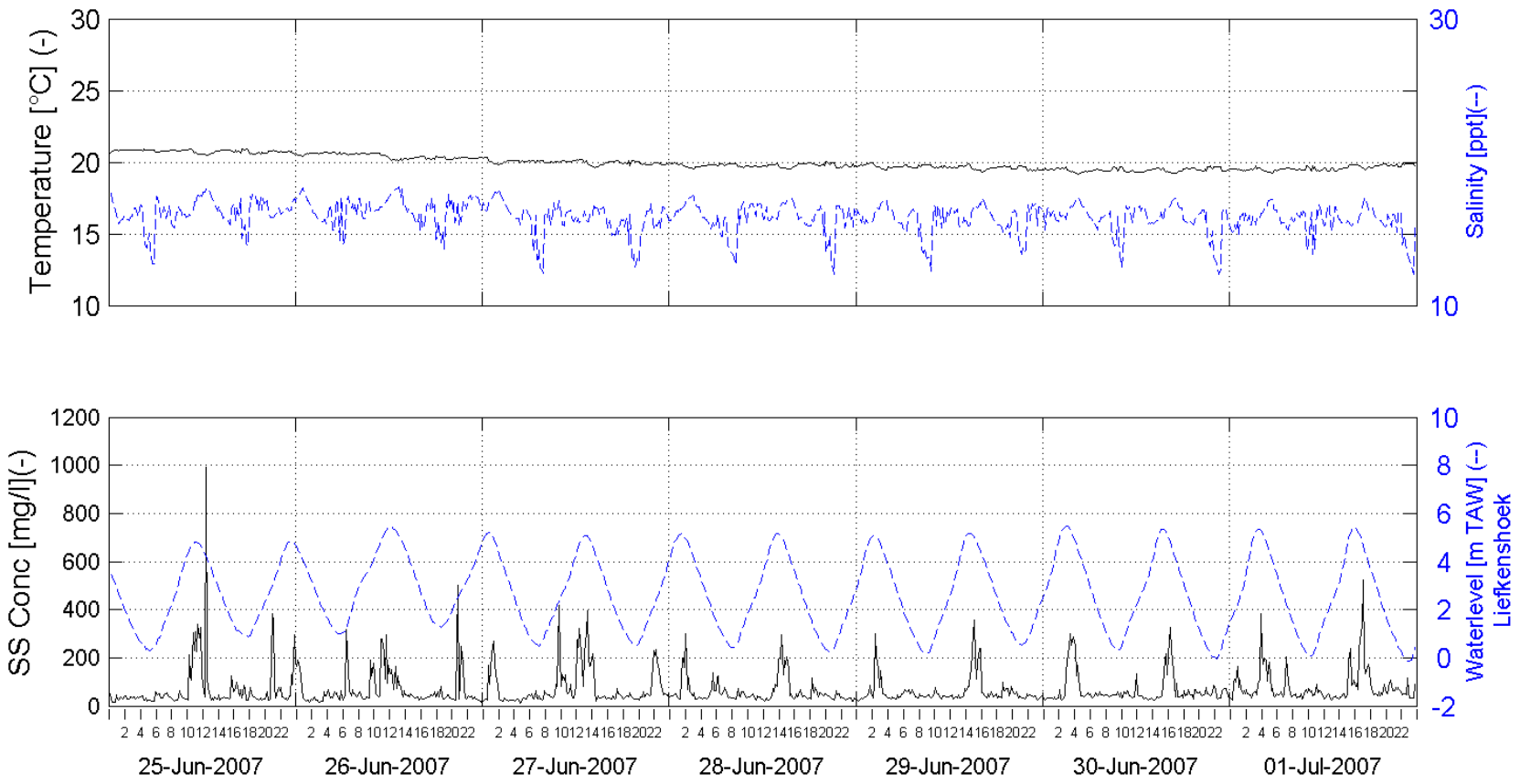
IMDC

In Association with:

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 26 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 5.5m above bottom (-11.5m TAW)

Processed by:

IMDC

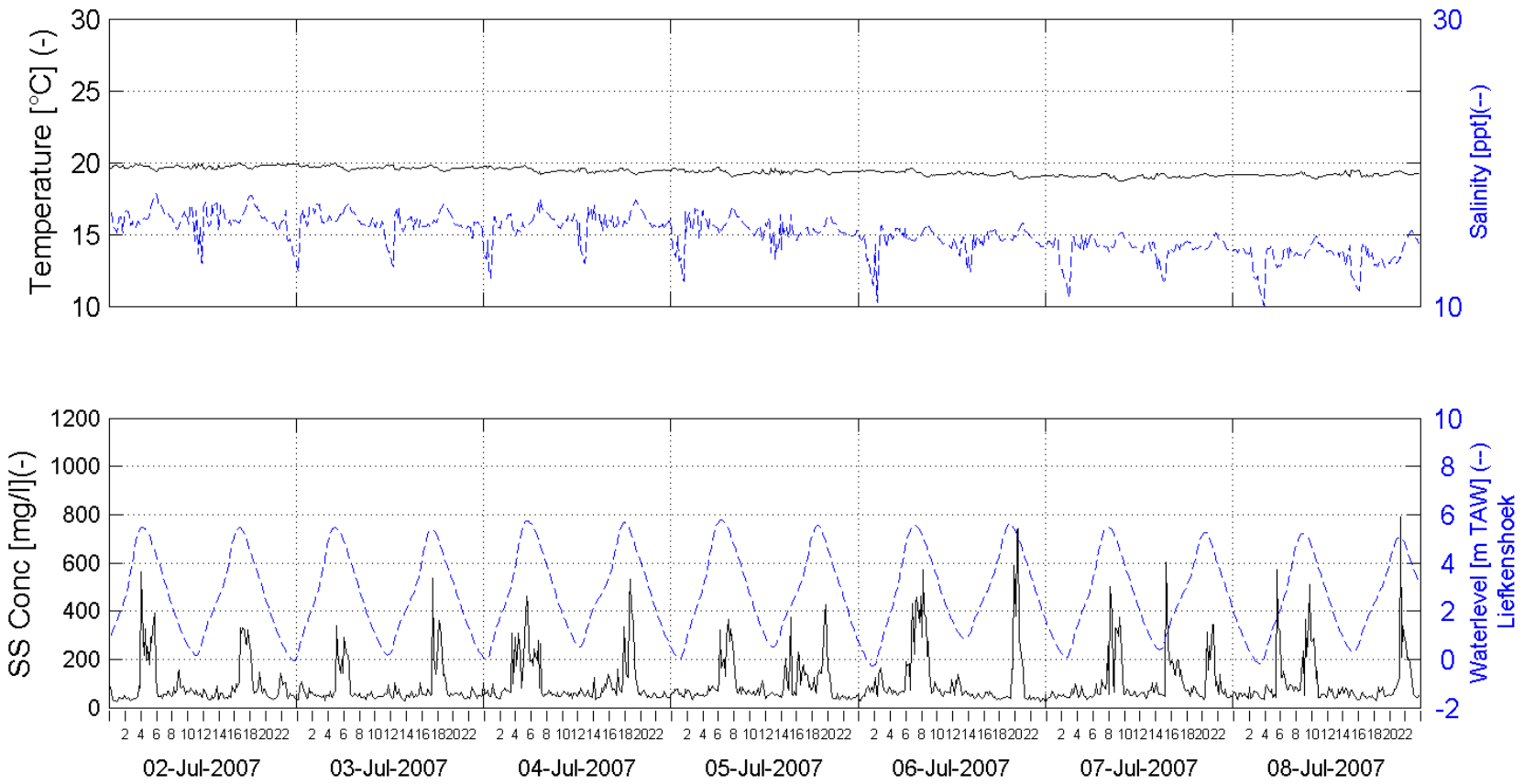
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 27 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 5.5m above bottom (-11.5m TAW)

Processed by:

IMDC

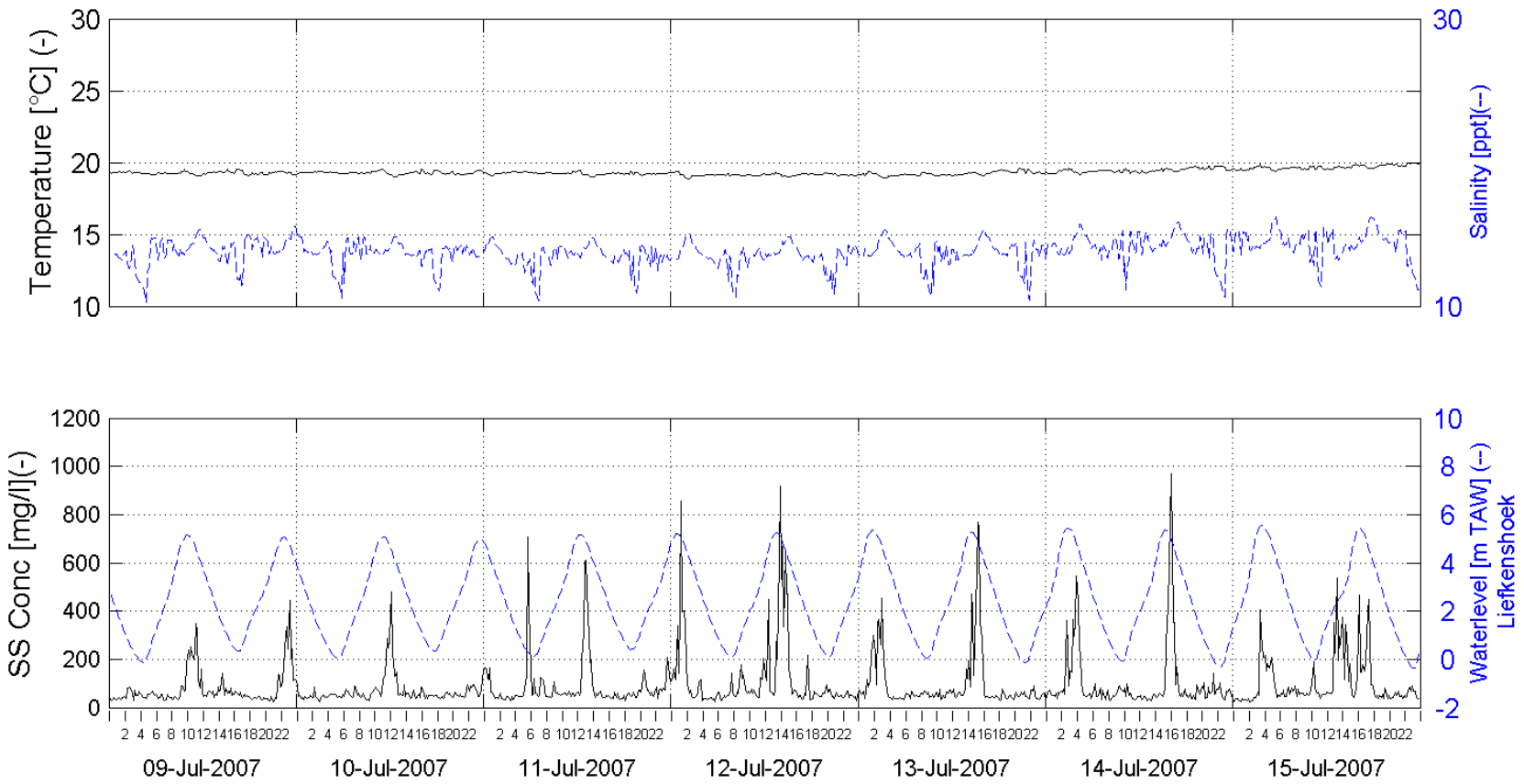
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 28 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 5.5m above bottom (-11.5m TAW)

Processed by:

IMDC

In Association with:

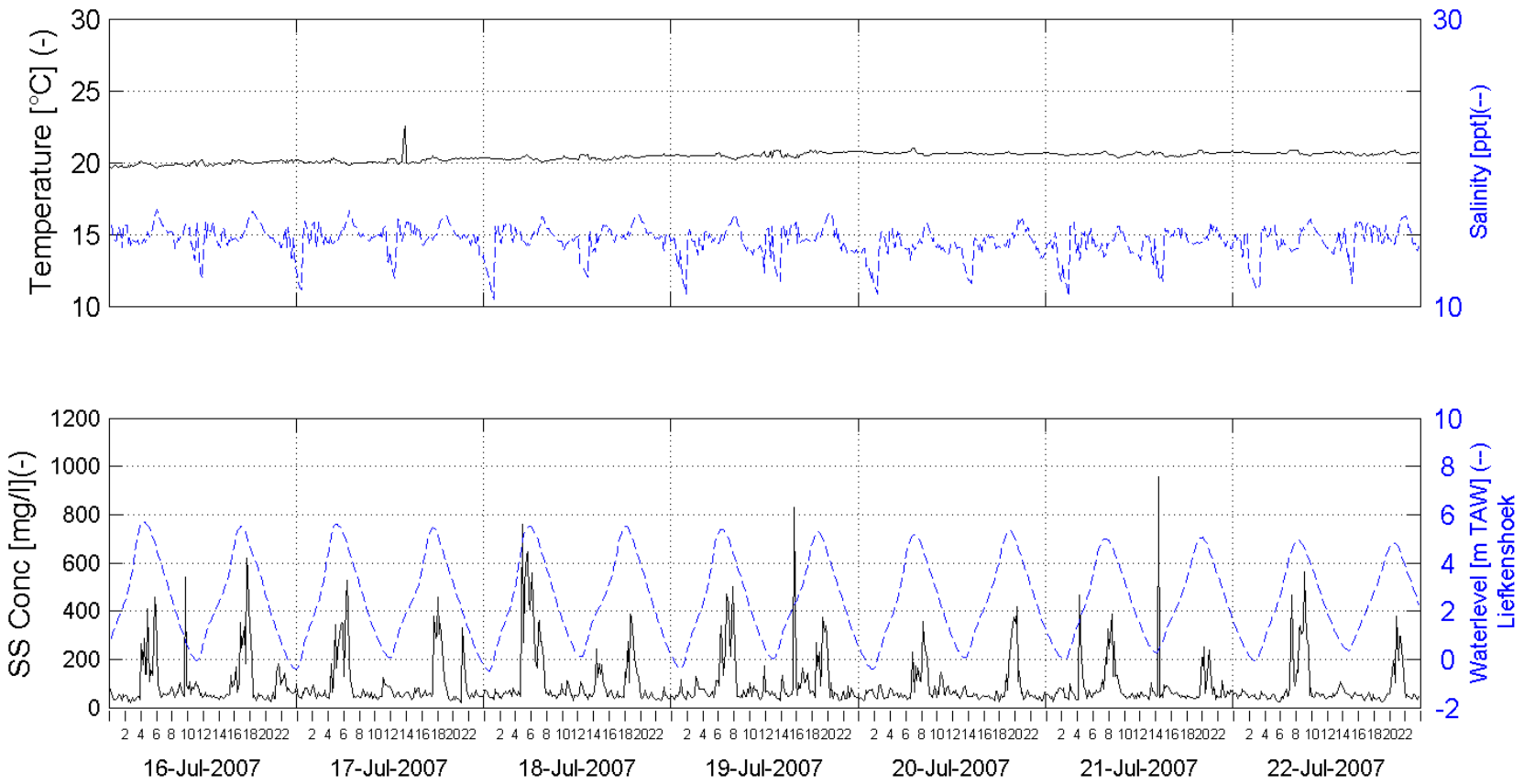
WL | delft hydraulics

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 29 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 5.5m above bottom (-11.5m TAW)

Processed by:

IMDC

In Association with:

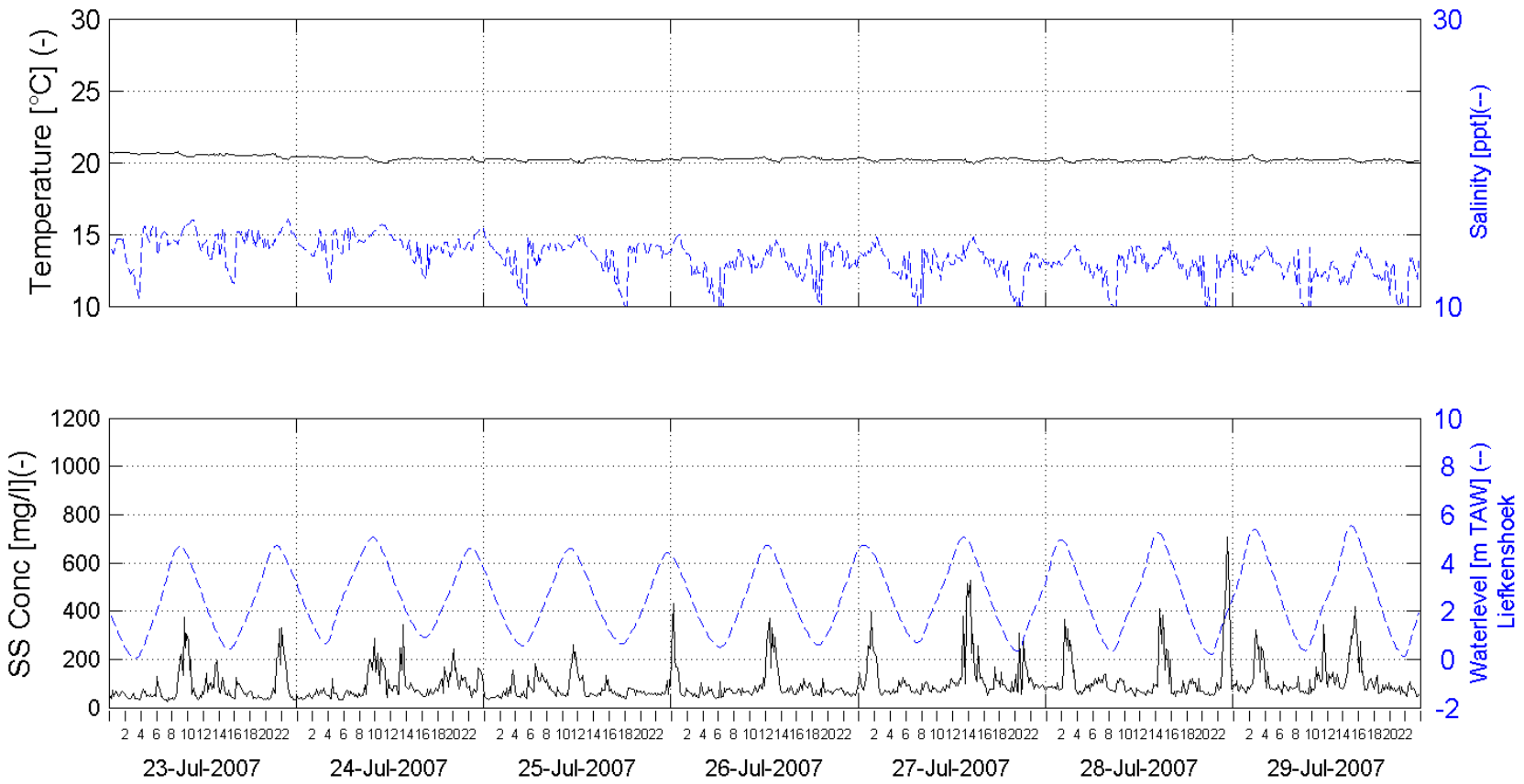
WL | delft hydraulics

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 30 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 5.5m above bottom (-11.5m TAW)

Processed by:

IMDC

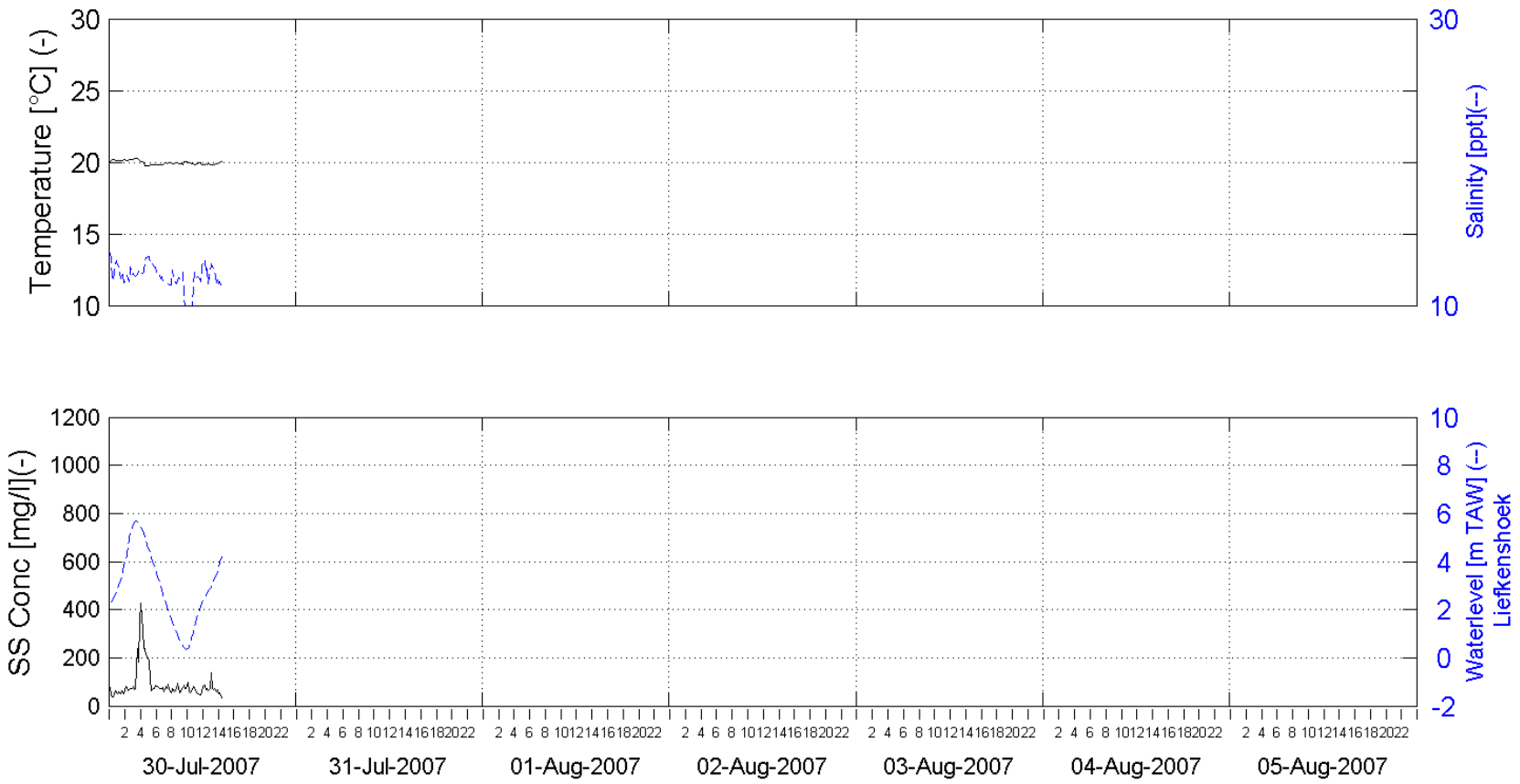
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 31 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 5.5m above bottom (-11.5m TAW)

Processed by:

IMDC

In Association with:

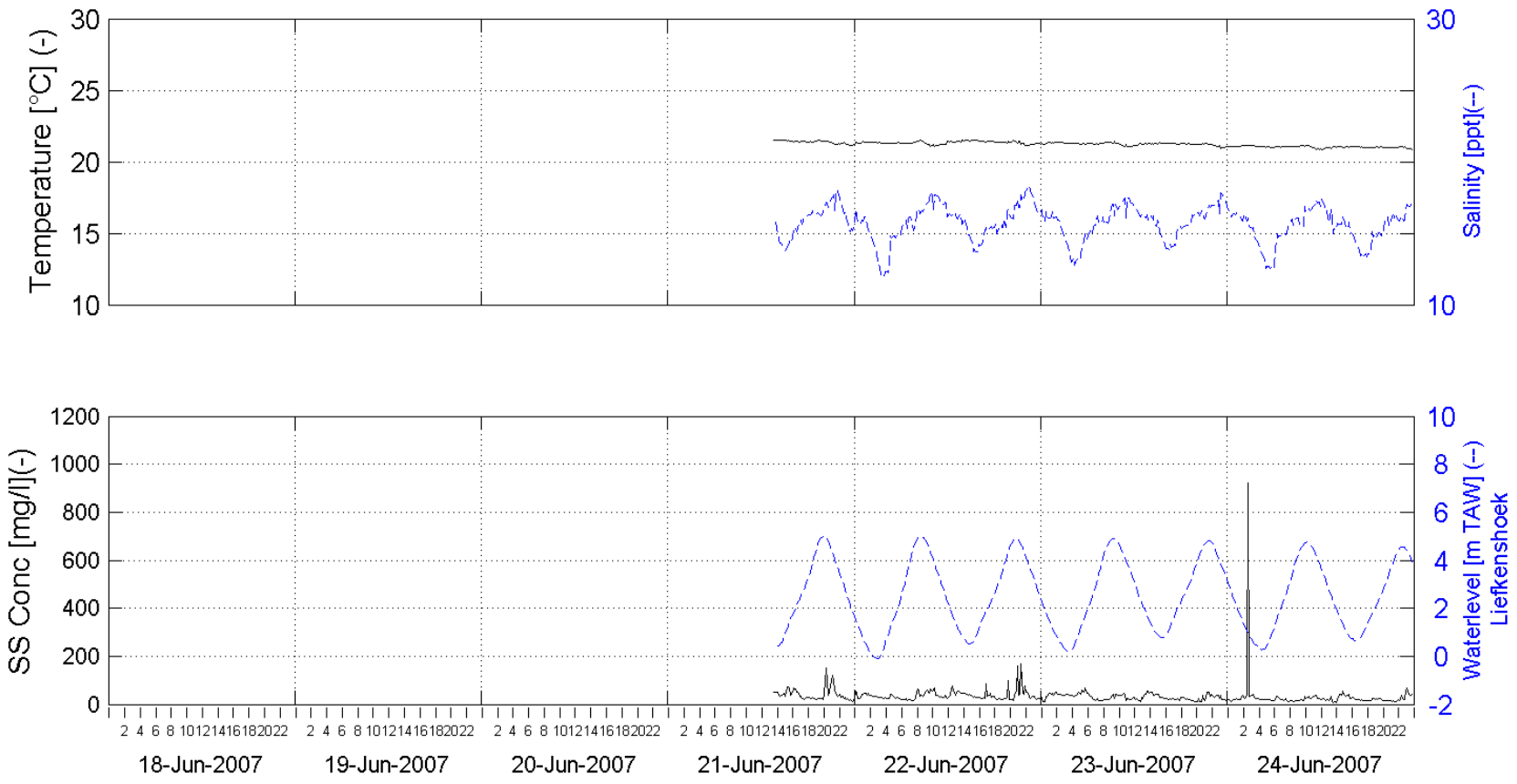
GEMS International

w.l | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 25 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 14.9m above bottom (-2.1m TAW)

Processed by:

IMDC

In Association with:

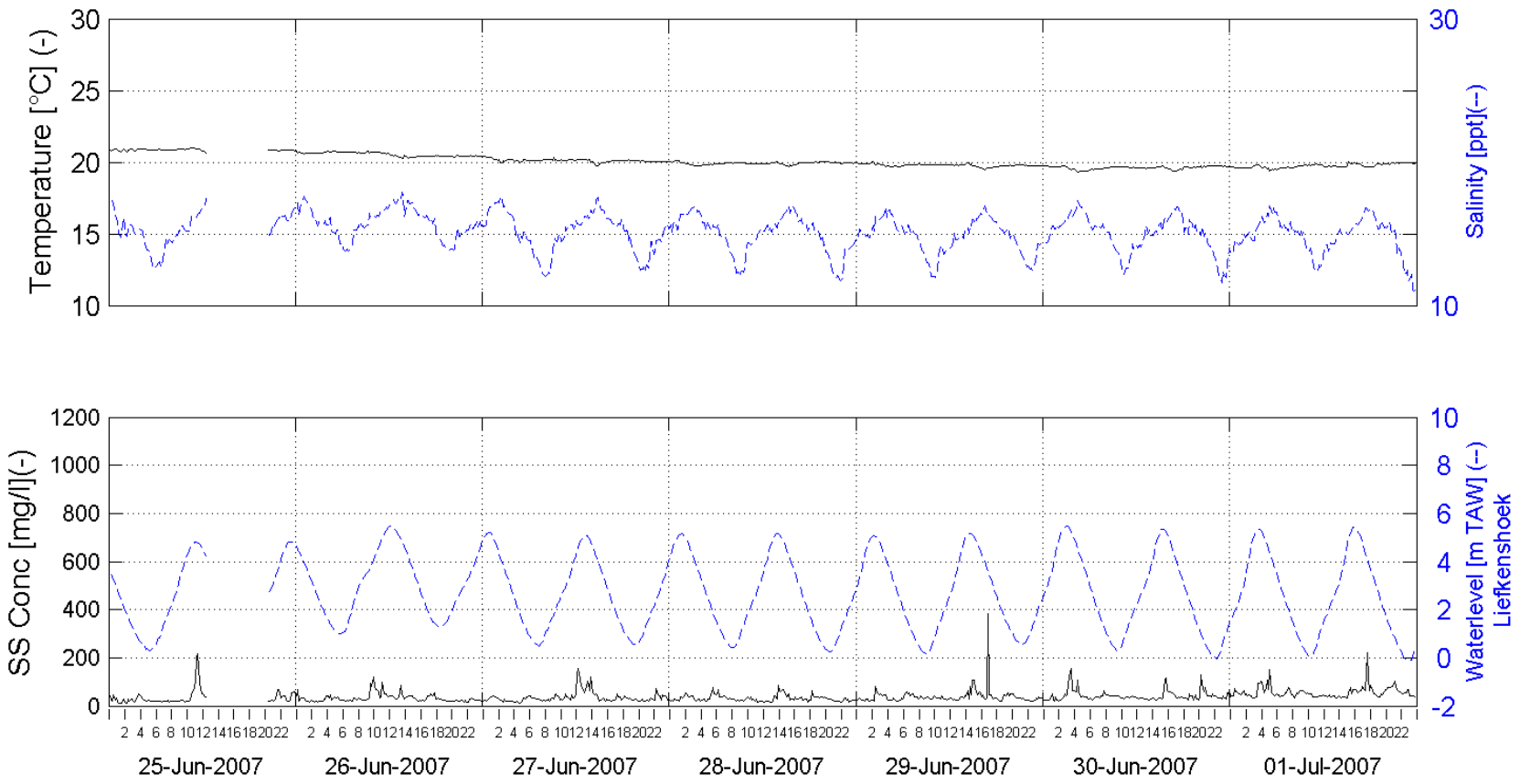
GEMS International

wl | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 26 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 14.9m above bottom (-2.1m TAW)

Processed by:

IMDC

In Association with:

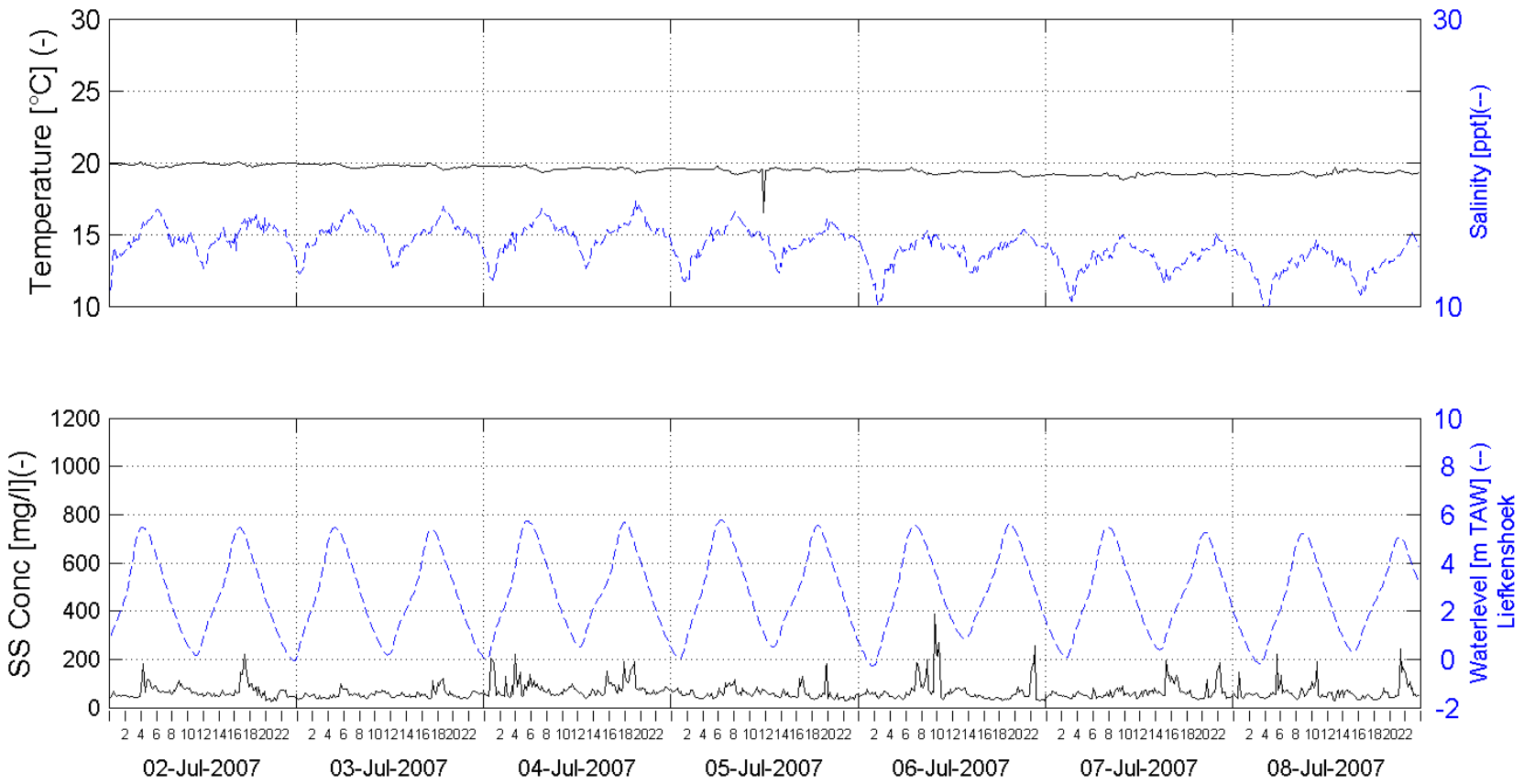
GEMS International

wl | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 27 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 14.9m above bottom (-2.1m TAW)

Processed by:

IMDC

In Association with:

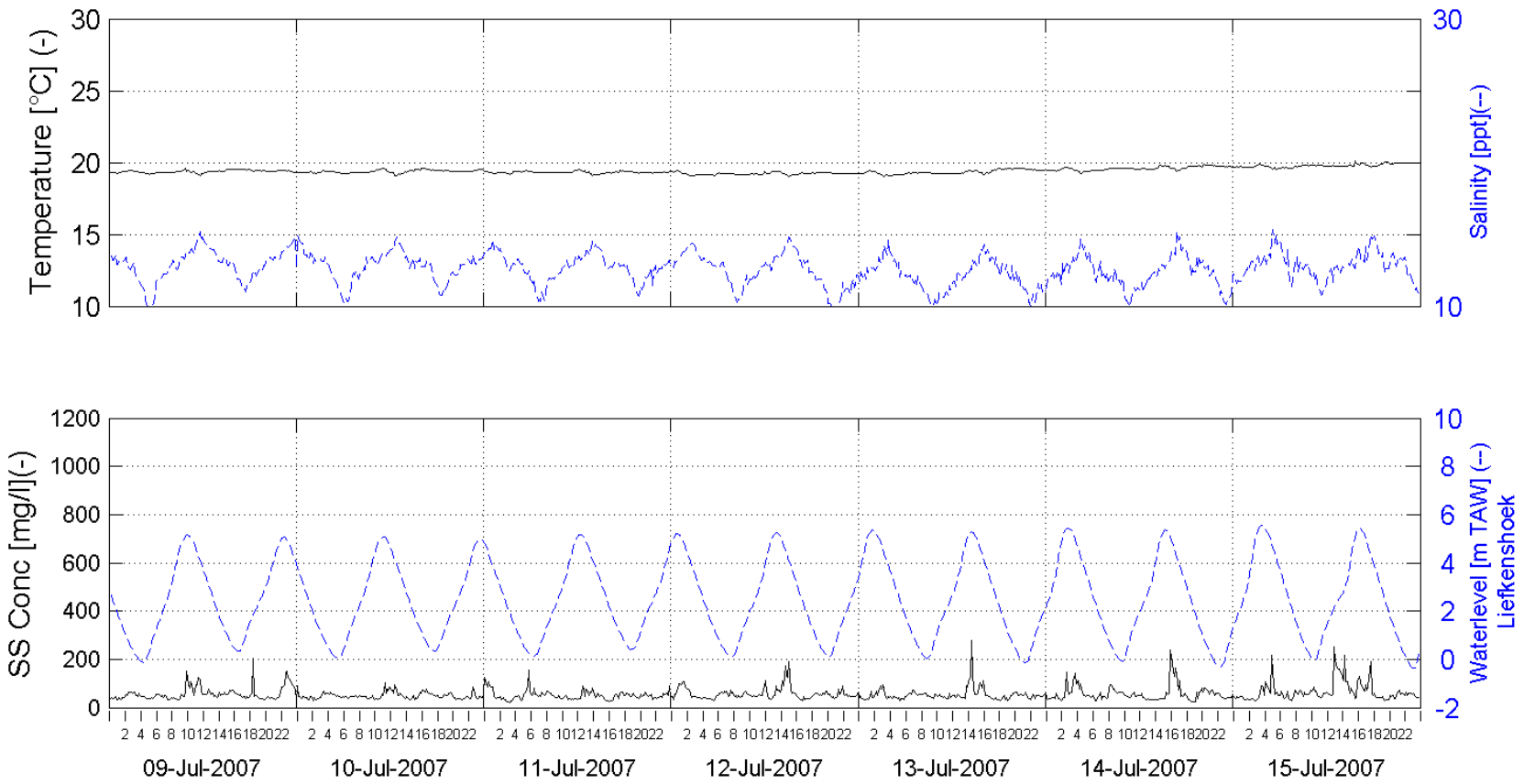
WL | delft hydraulics

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 28 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 14.9m above bottom (-2.1m TAW)

Processed by:

IMDC

In Association with:

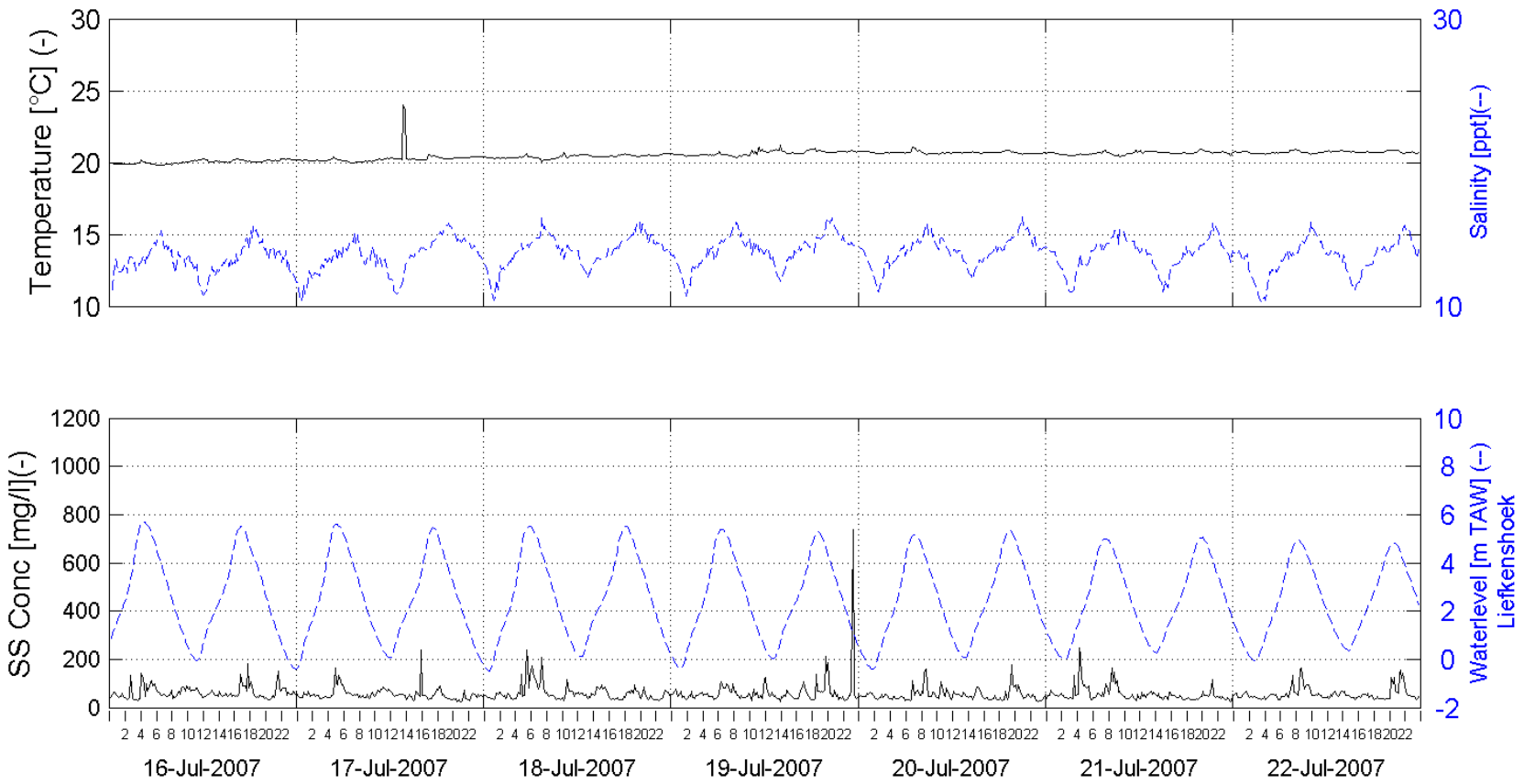
GEMS International

wl | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 29 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 14.9m above bottom (-2.1m TAW)

Processed by:

IMDC

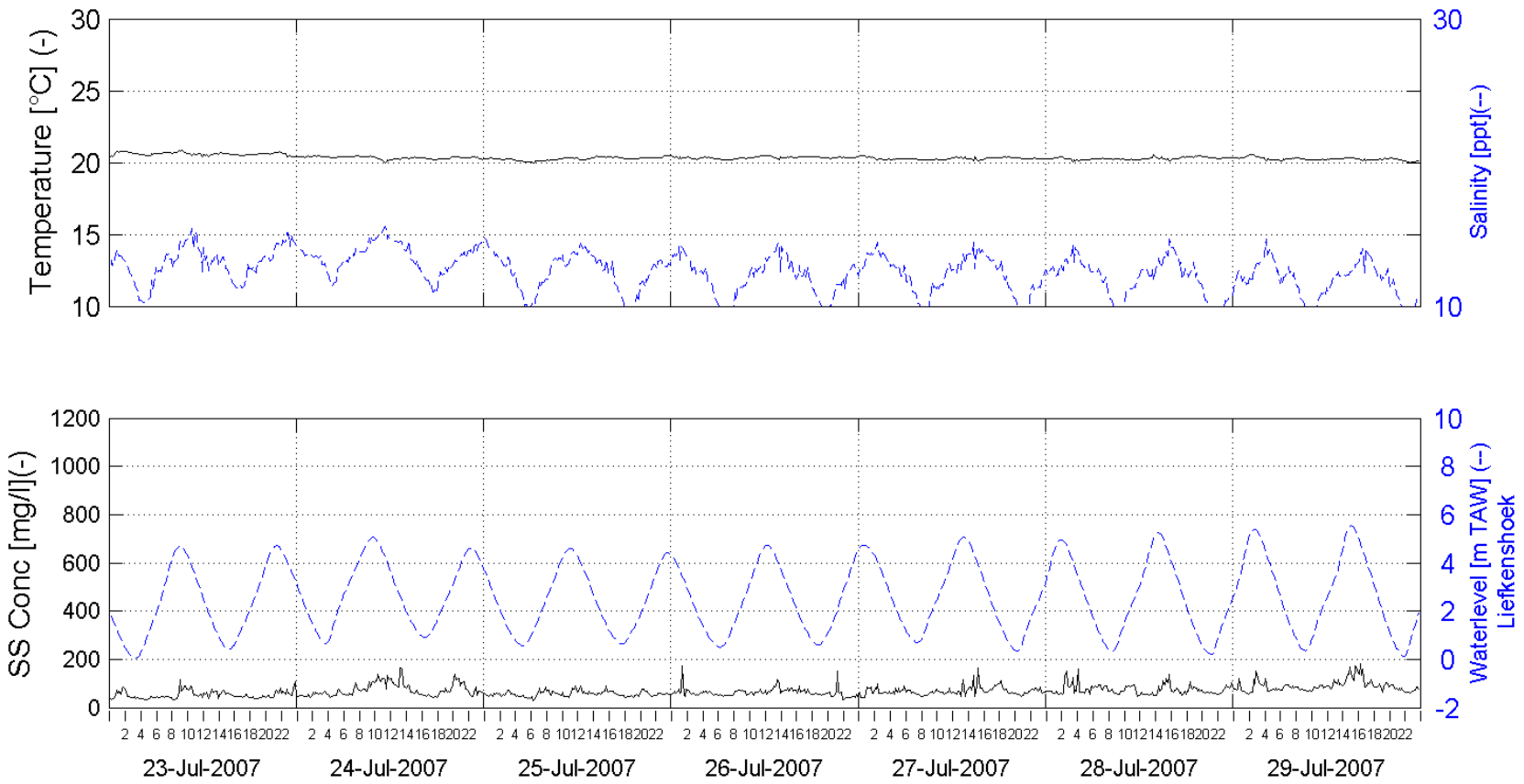
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 30 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 14.9m above bottom (-2.1m TAW)

Processed by:

IMDC

In Association with:

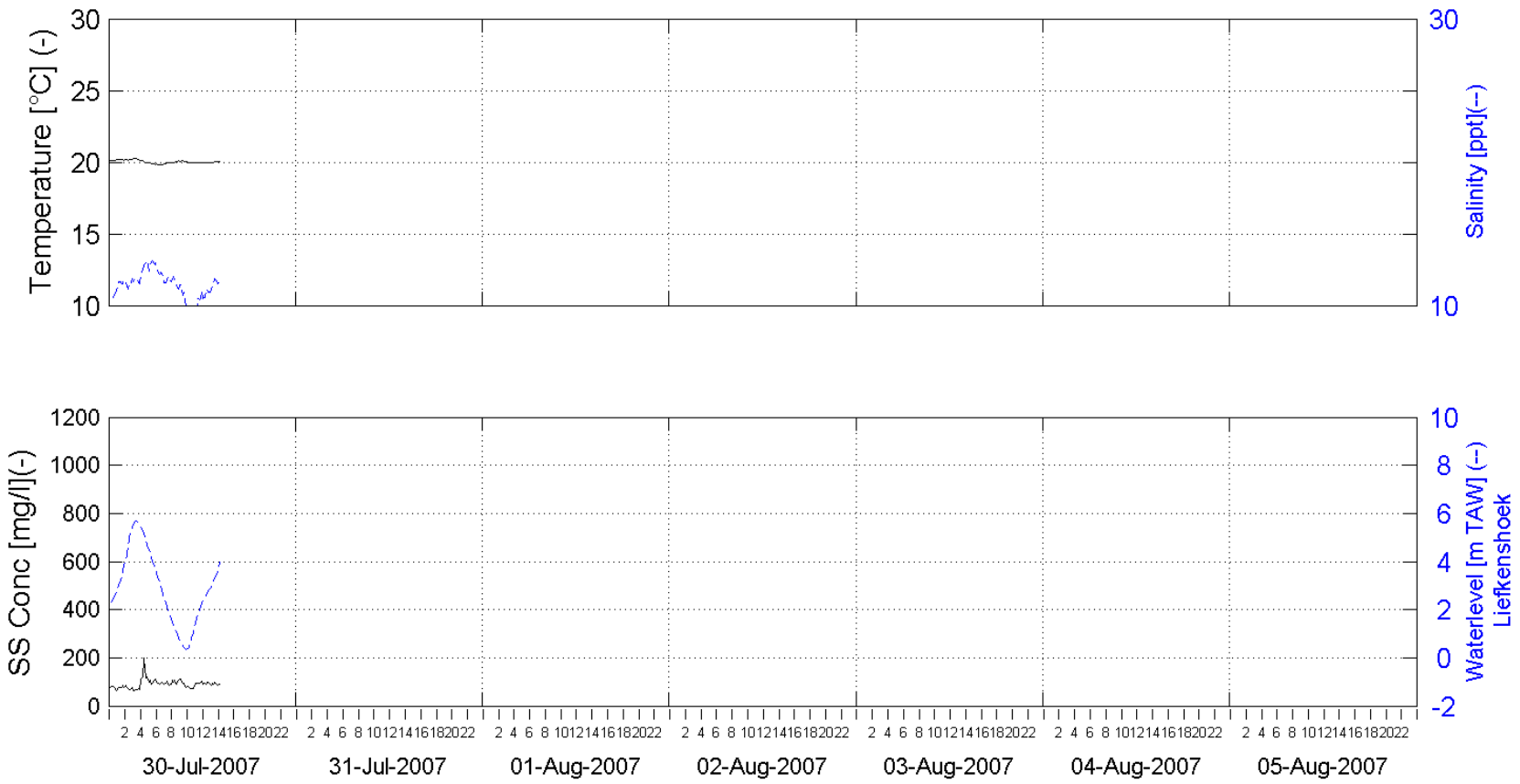
GEMS International

wl | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 31 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD N-ENTRANCE 14.9m above bottom (-2.1m TAW)

Processed by:

IMDC

In Association with:

GEMS International

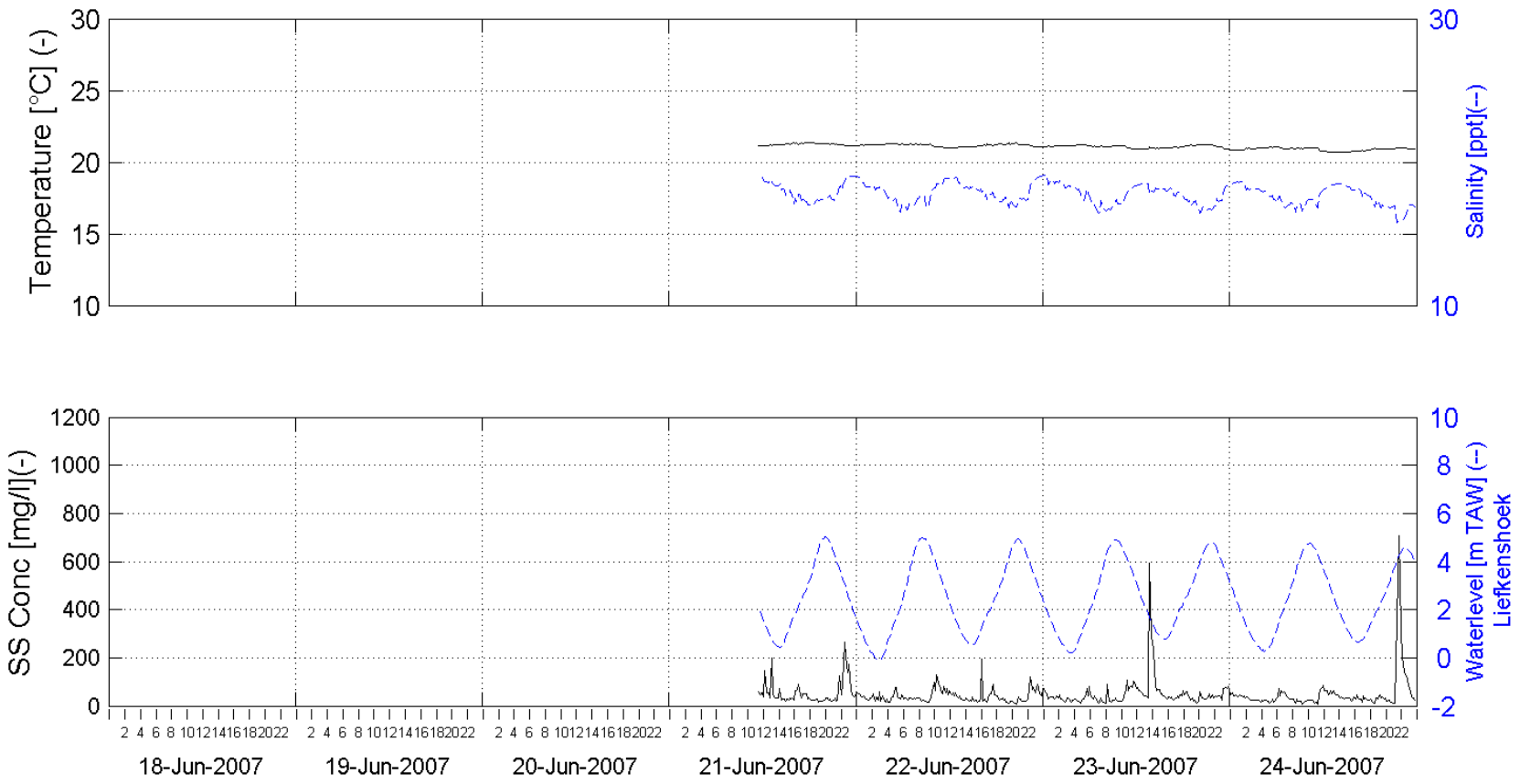
wl | delft hydraulics

I/RA/11283/07.092/MSA

B.2 P&O1 (S-BACK)

11283 - Long-term monitoring DGD - Summer 2007

Week 25 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 4.9m above bottom (-12.1m TAW)

Processed by:

IMDC

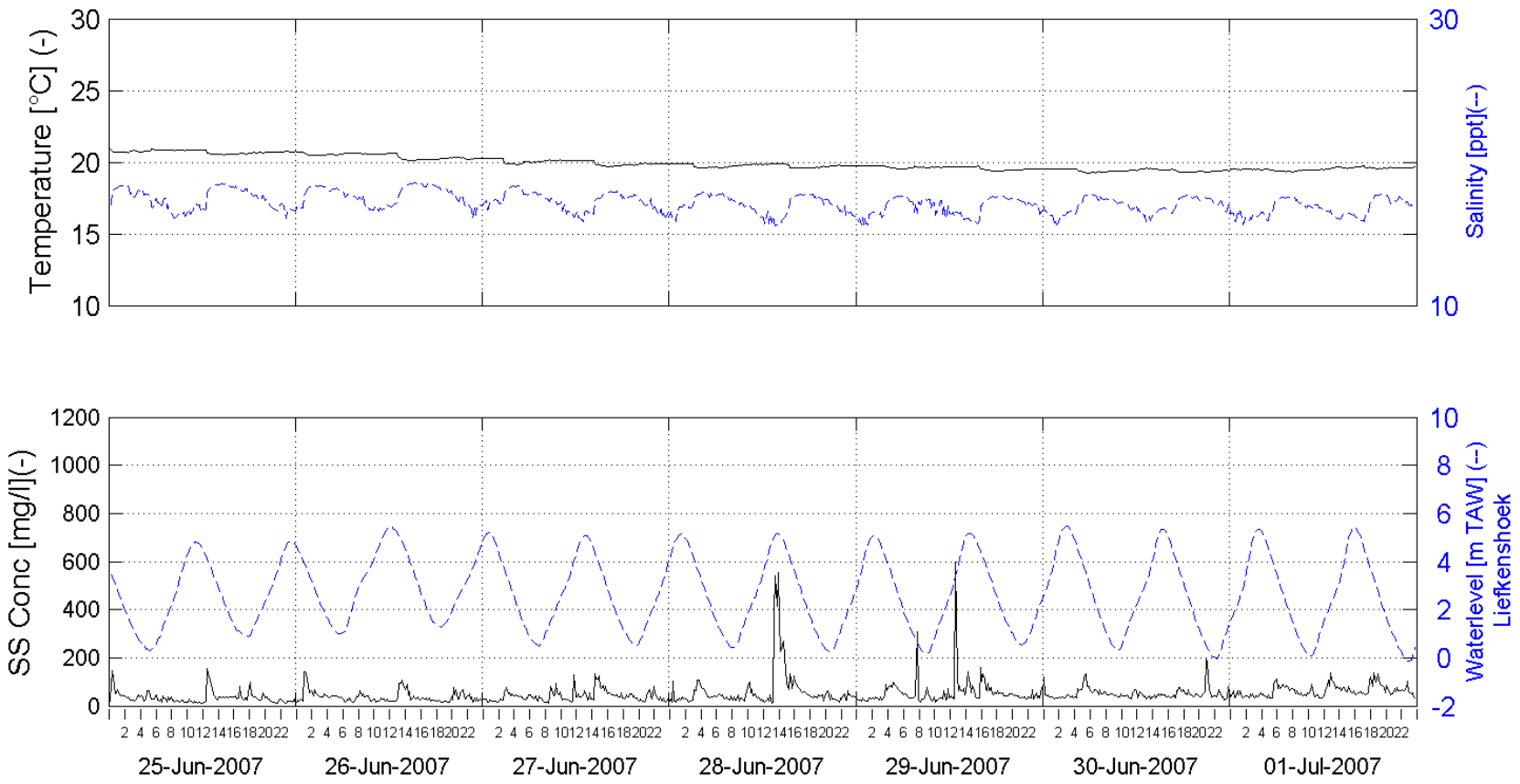
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 26 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 4.9m above bottom (-12.1m TAW)

Processed by:

IMDC

In Association with:

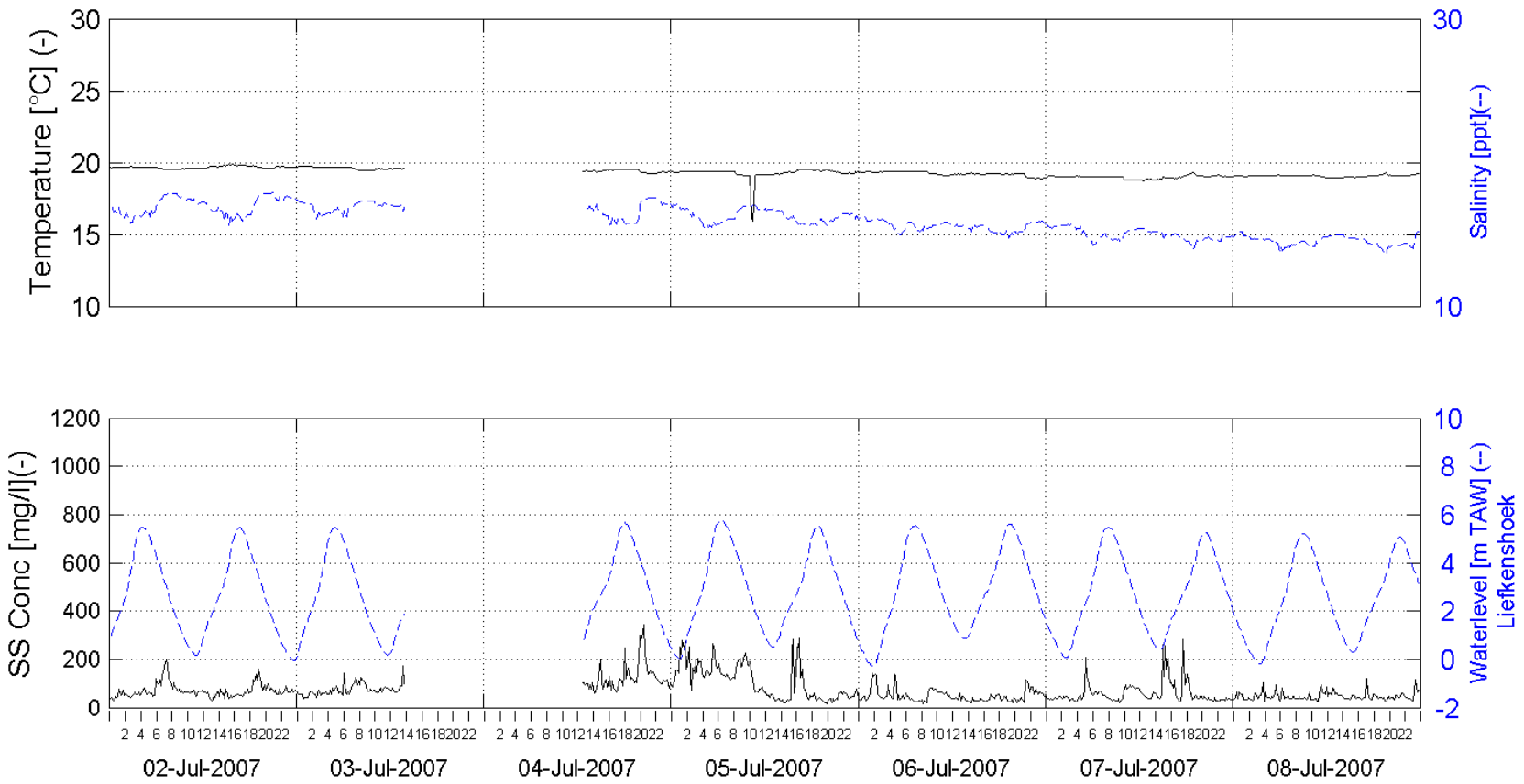
GEMS International

wl | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 27 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 4.9m above bottom (-12.1m TAW)

Processed by:

IMDC

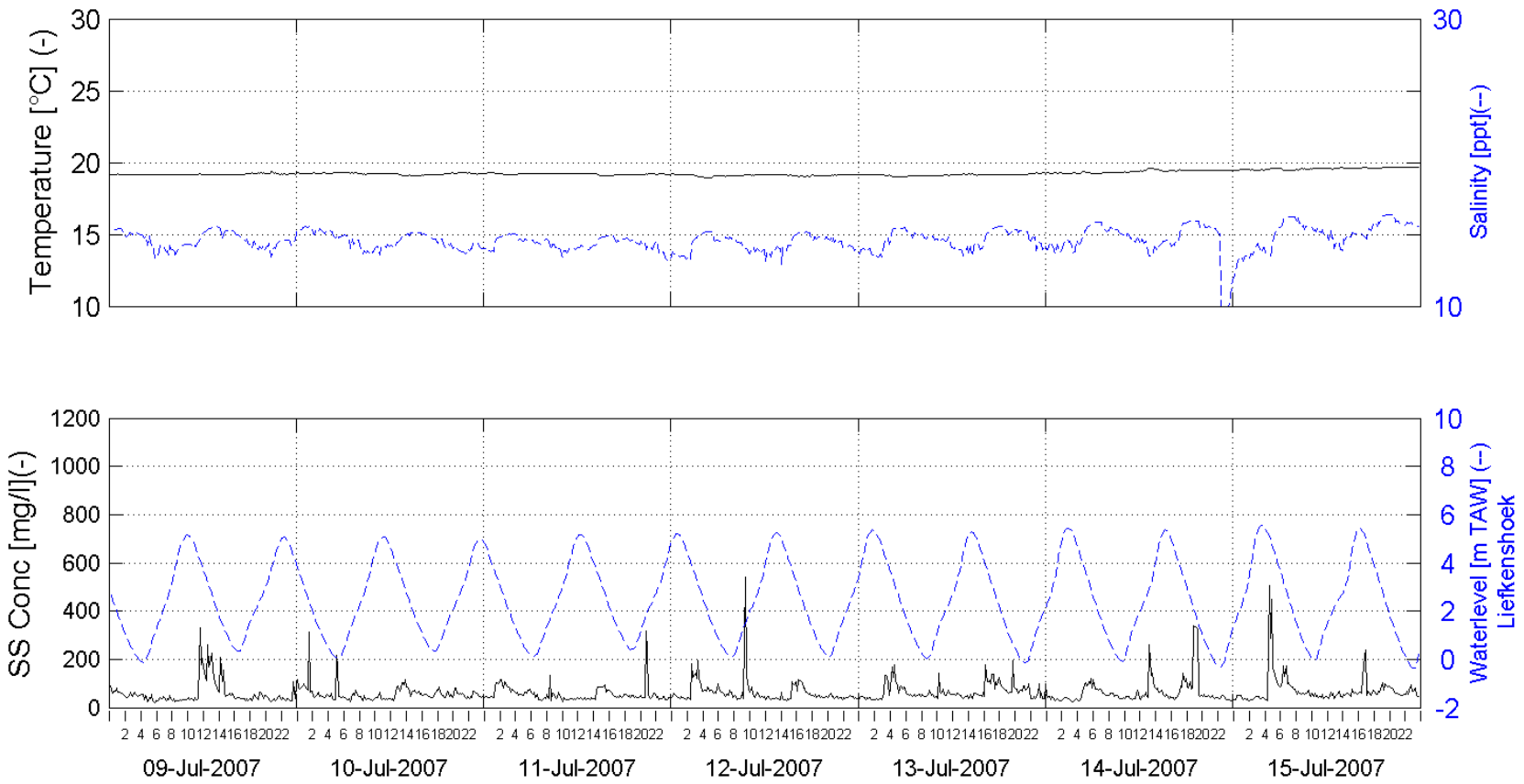
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 28 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 4.9m above bottom (-12.1m TAW)

Processed by:

IMDC

In Association with:

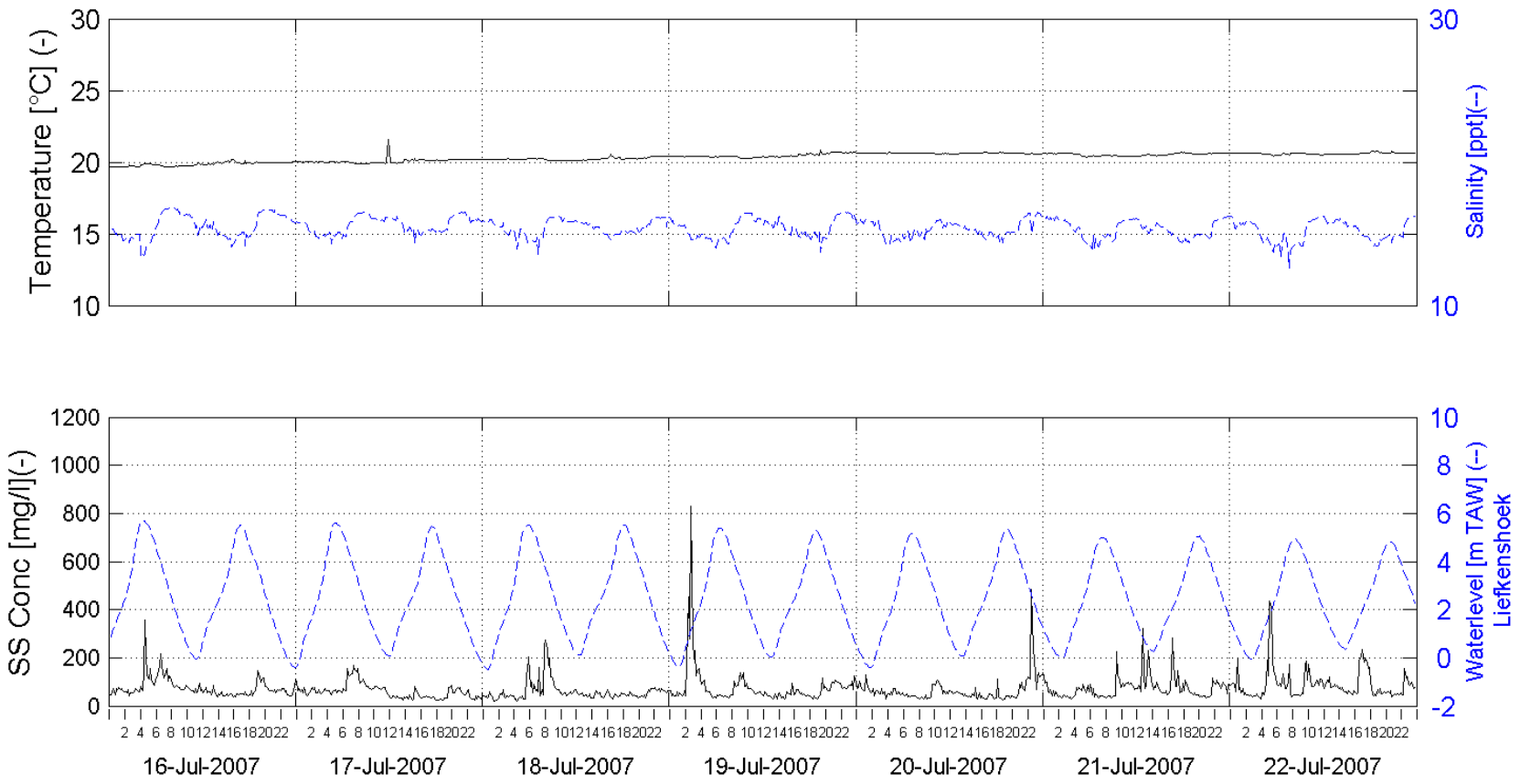
GEMS International

wl | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 29 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 4.9m above bottom (-12.1m TAW)

Processed by:

IMDC

In Association with:

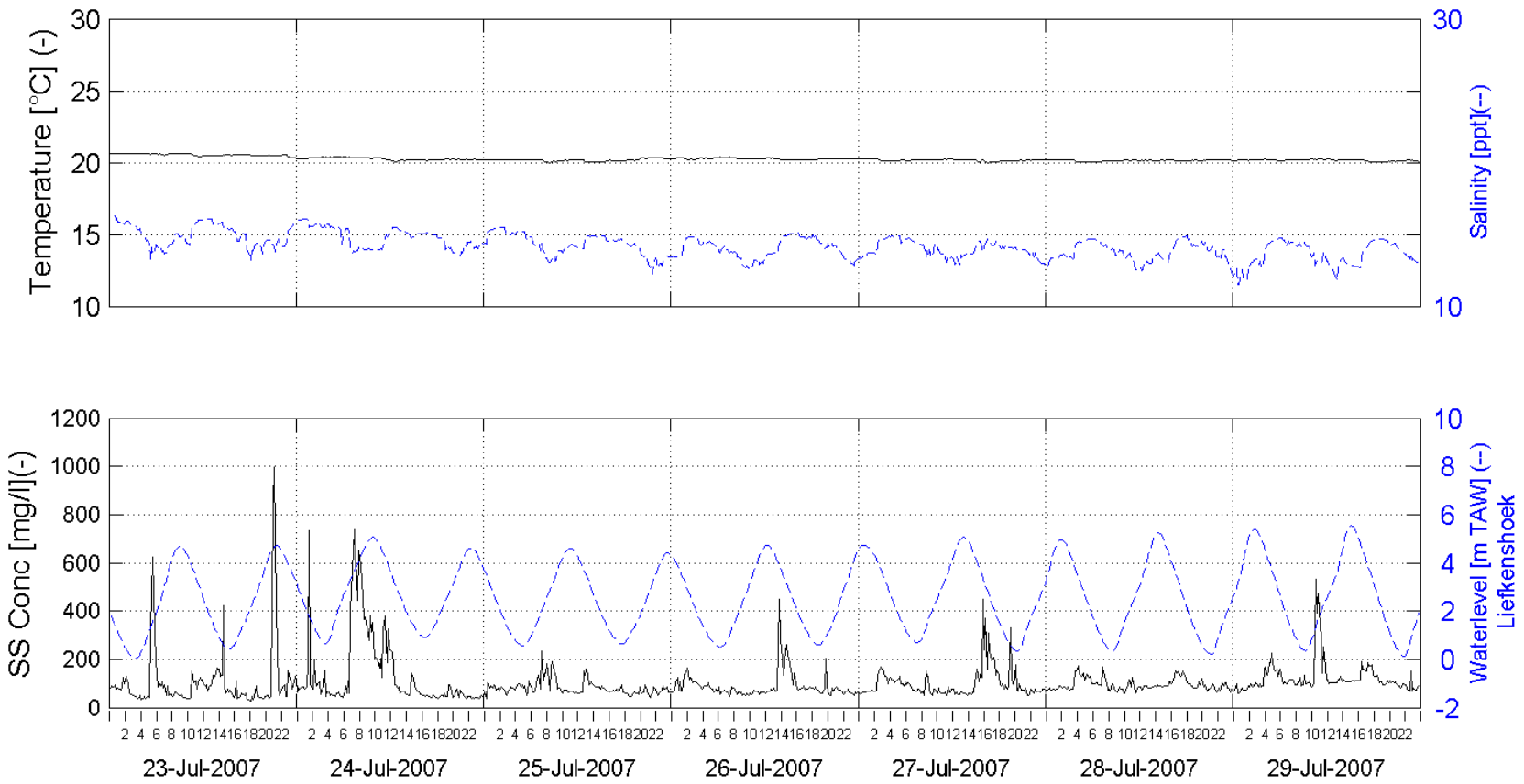
GEMS International

wl | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 30 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 4.9m above bottom (-12.1m TAW)

Processed by:

IMDC

In Association with:

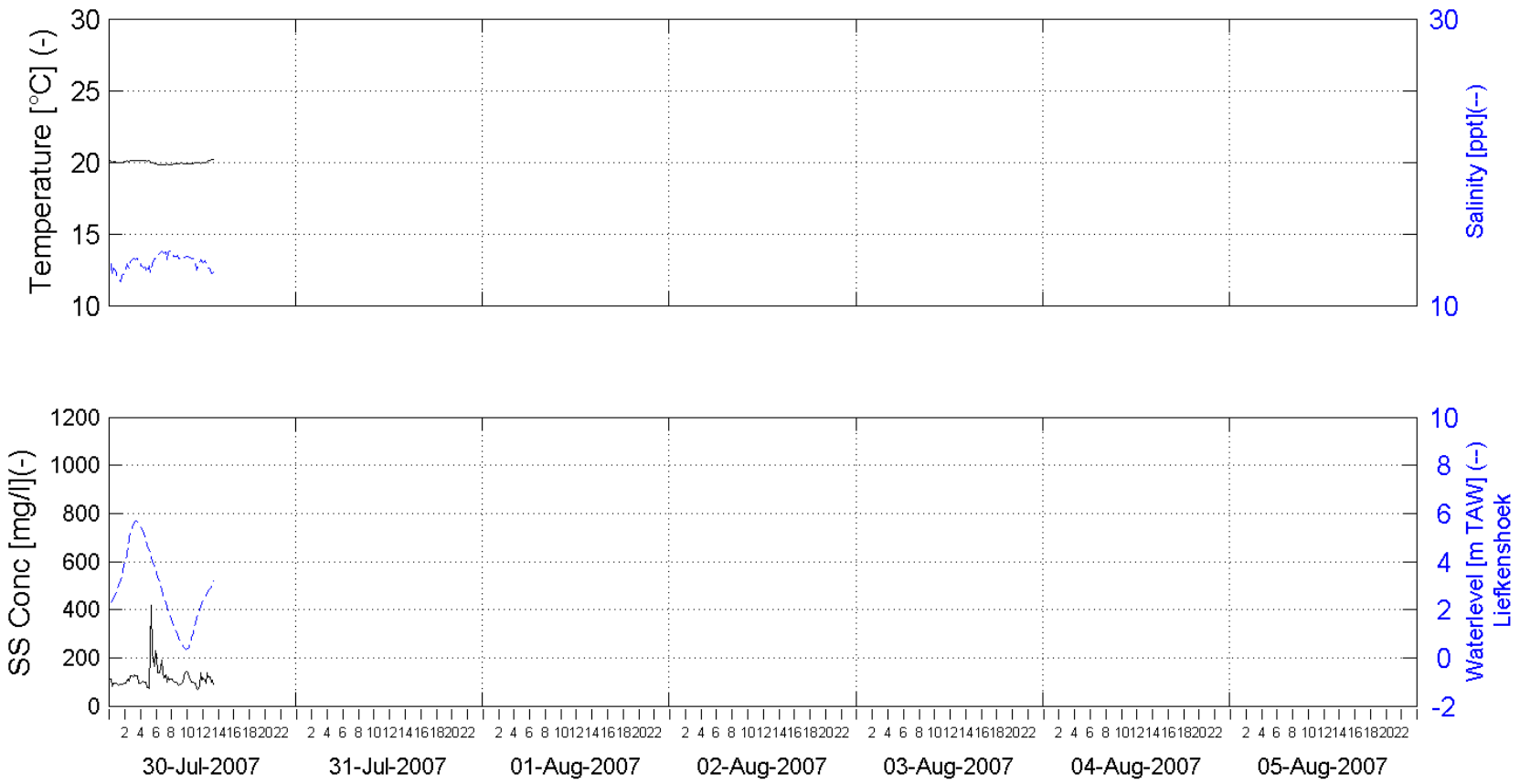
GEMS International

wl | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 31 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 4.9m above bottom (-12.1m TAW)

Processed by:

IMDC

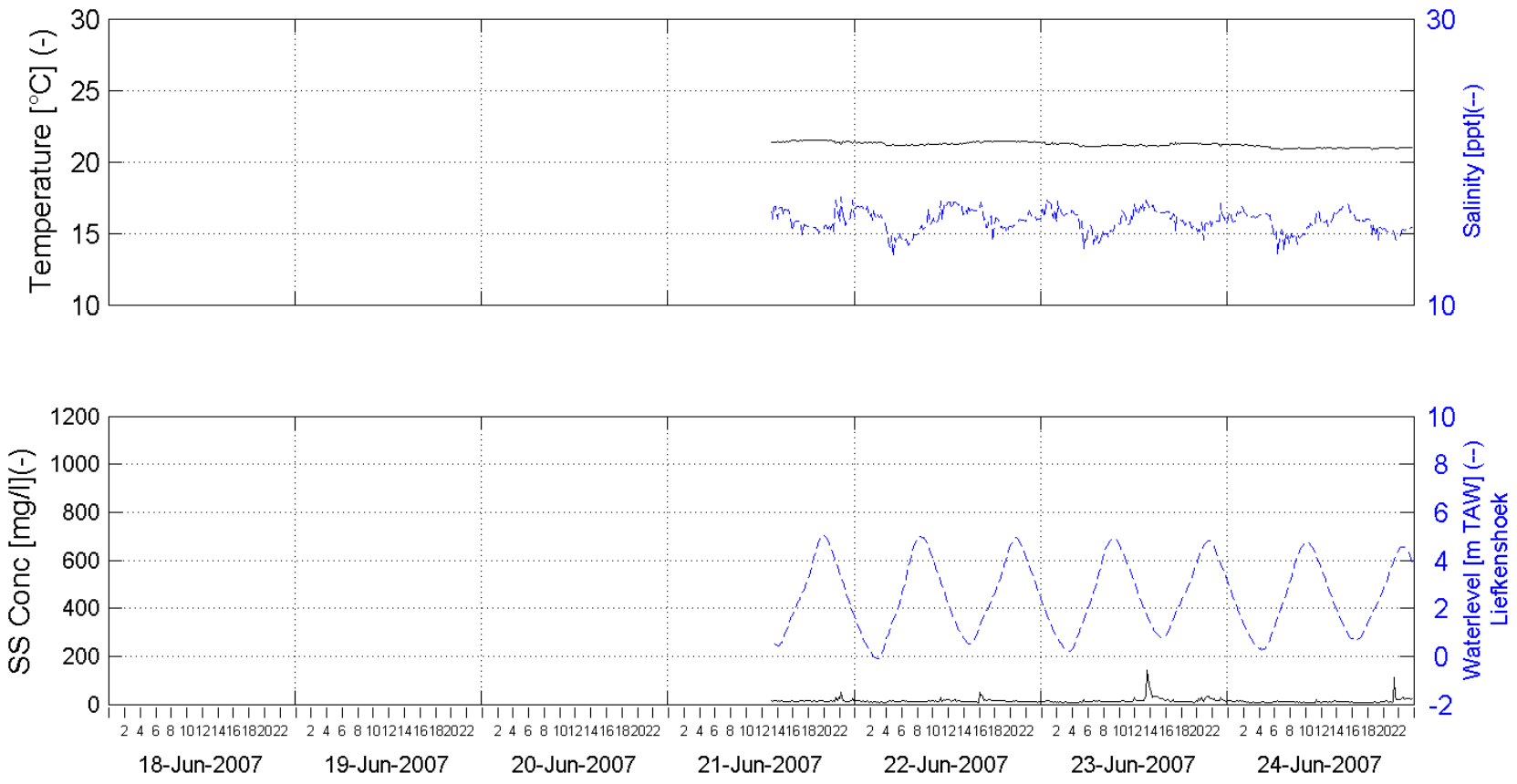
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 25 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 14.5m above bottom (-2.5m TAW)

Processed by:

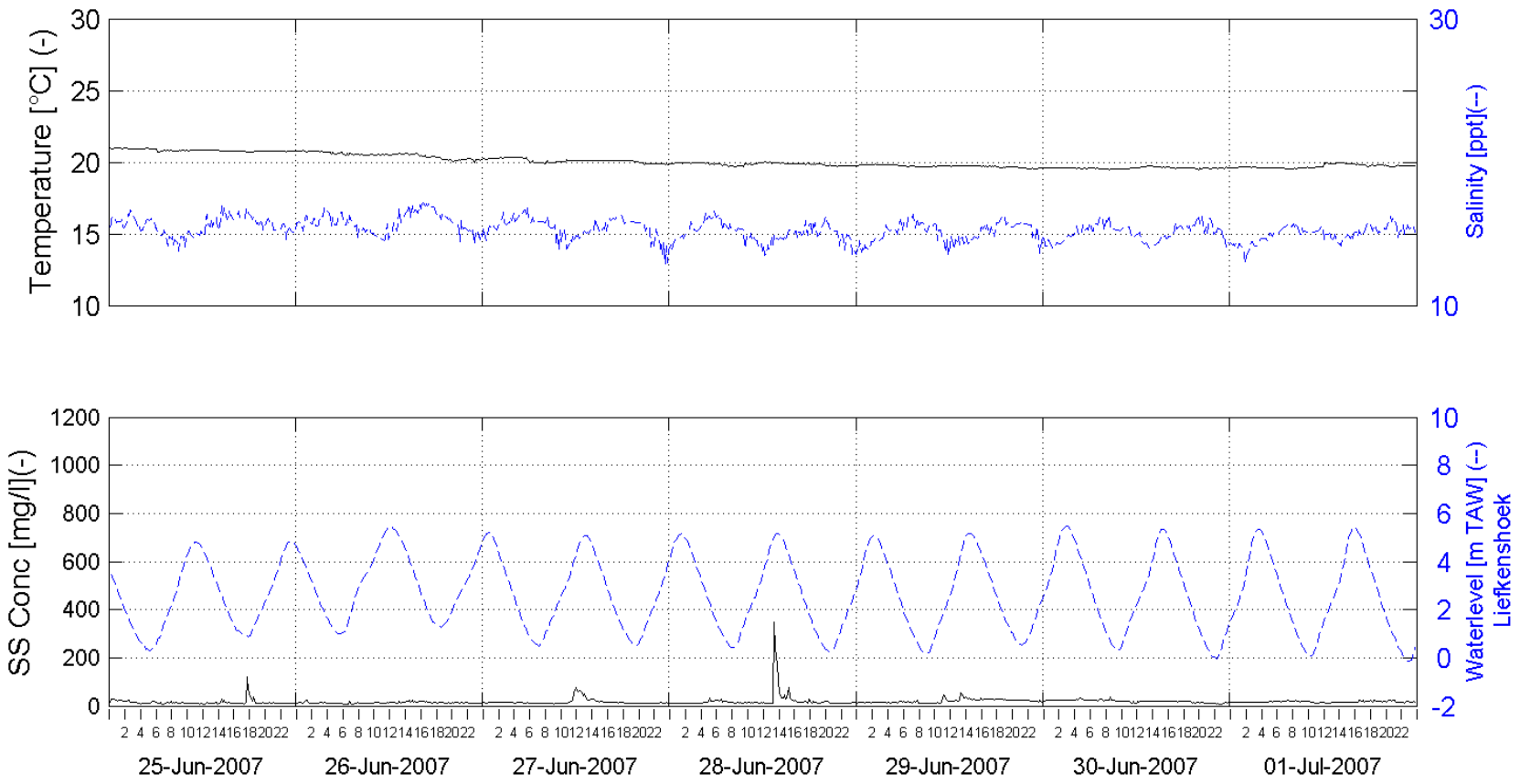
IMDC

In Association with:

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 26 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 14.5m above bottom (-2.5m TAW)

Processed by:

IMDC

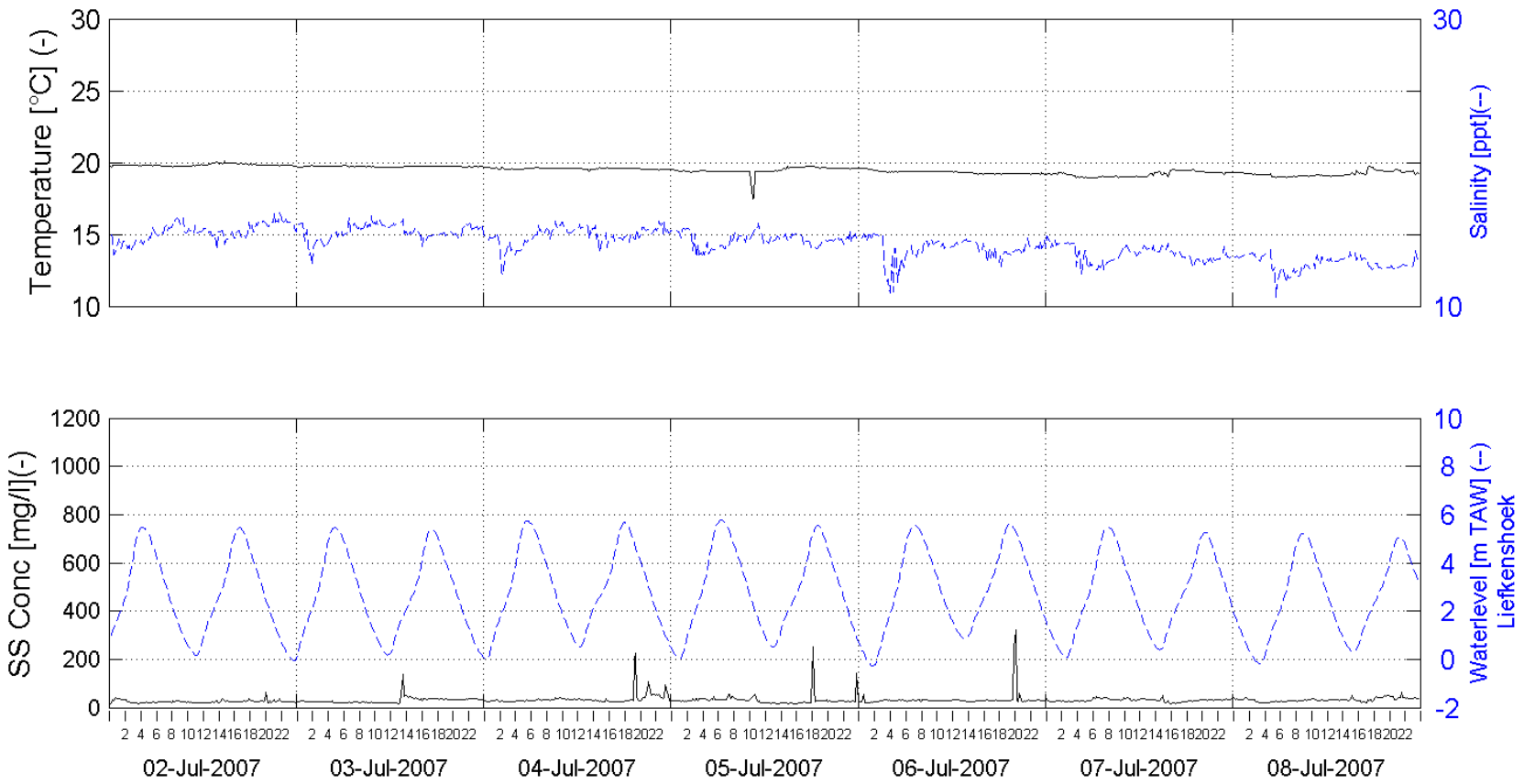
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 27 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 14.5m above bottom (-2.5m TAW)

Processed by:

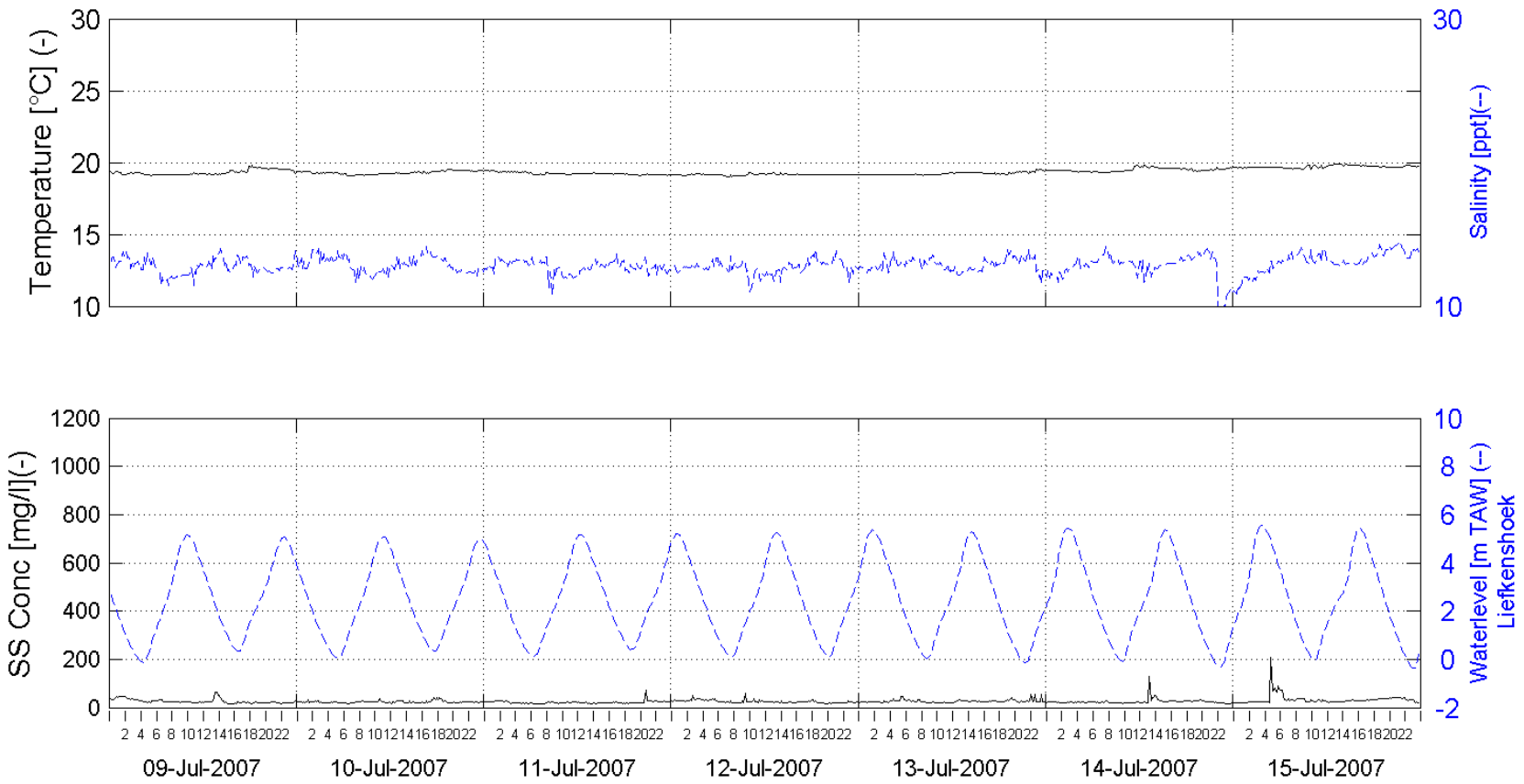
IMDC

In Association with:

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 28 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 14.5m above bottom (-2.5m TAW)

Processed by:

IMDC

In Association with:

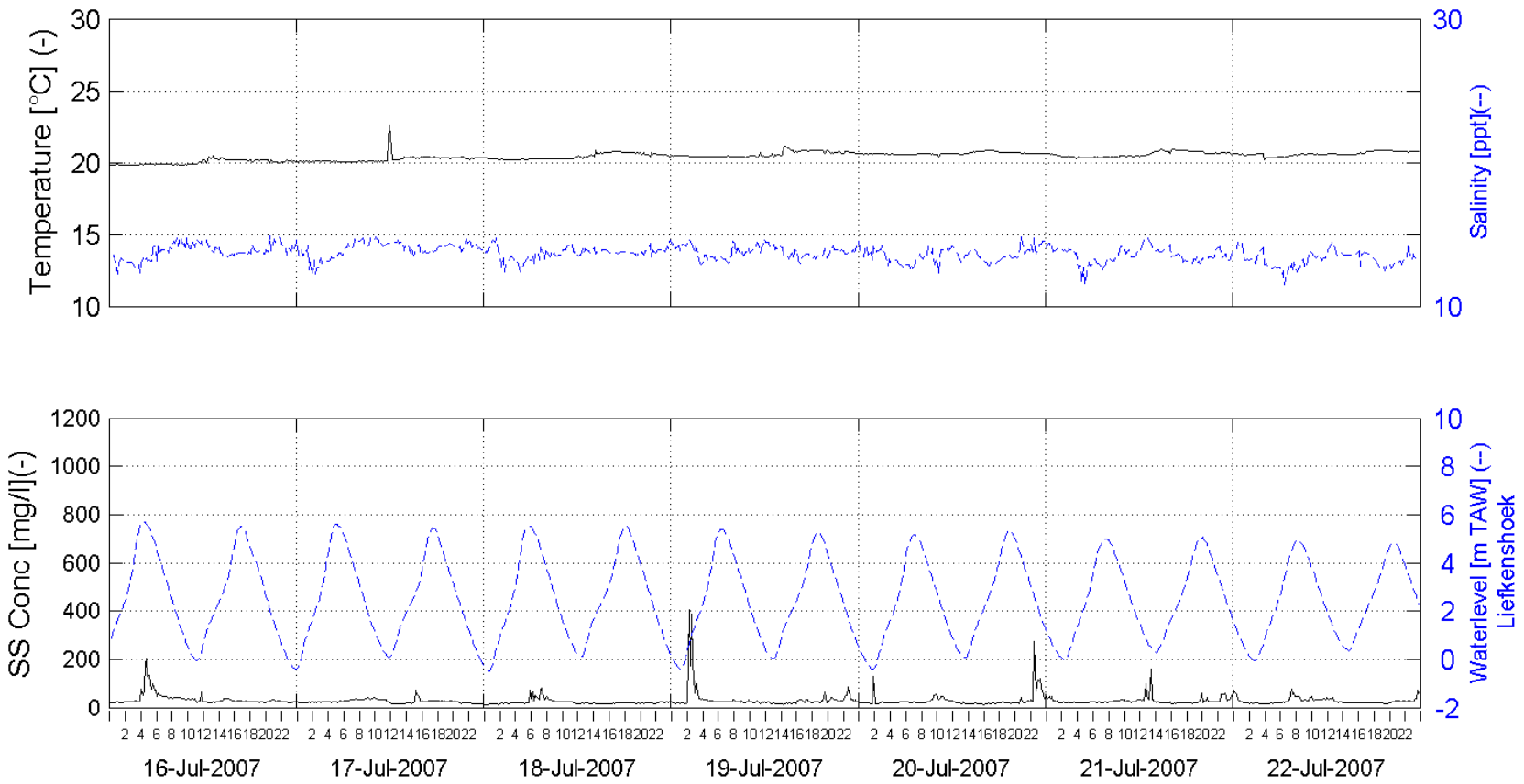
GEMS International

wl | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 29 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 14.5m above bottom (-2.5m TAW)

Processed by:

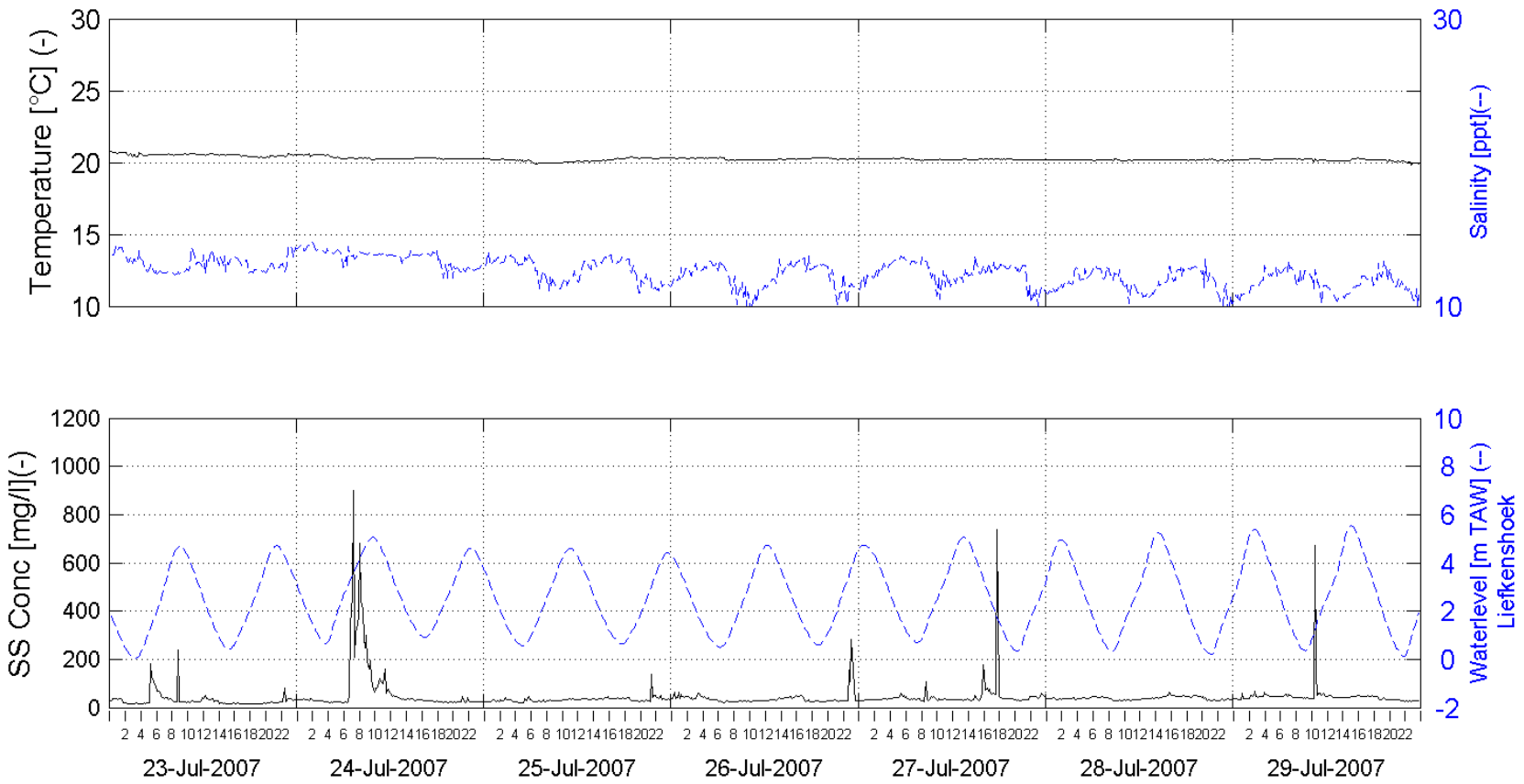
IMDC

In Association with:

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 30 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 14.5m above bottom (-2.5m TAW)

Processed by:

IMDC

In Association with:

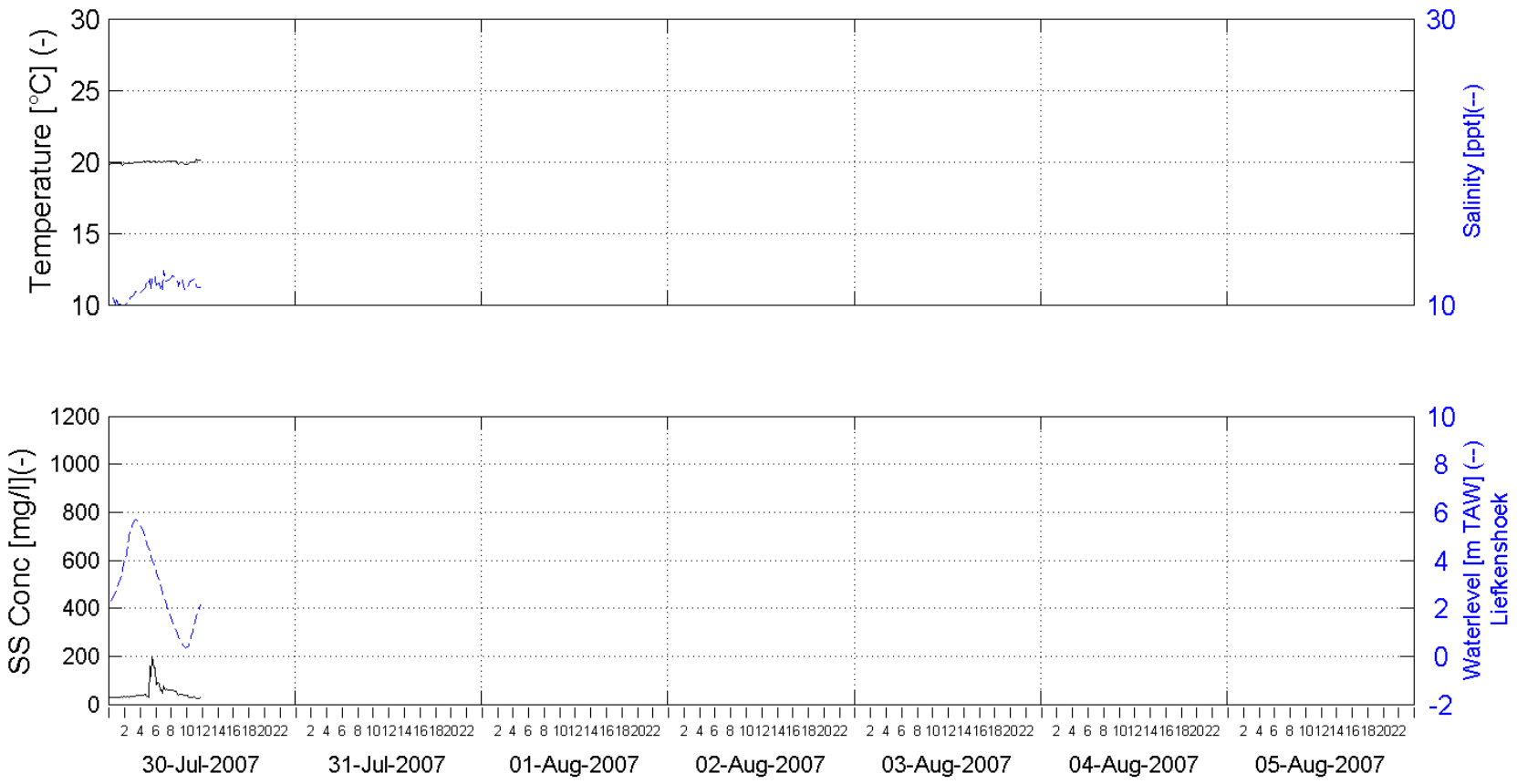
GEMS International

wl | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 31 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-BACK 14.5m above bottom (-2.5m TAW)

Processed by:

IMDC

In Association with:

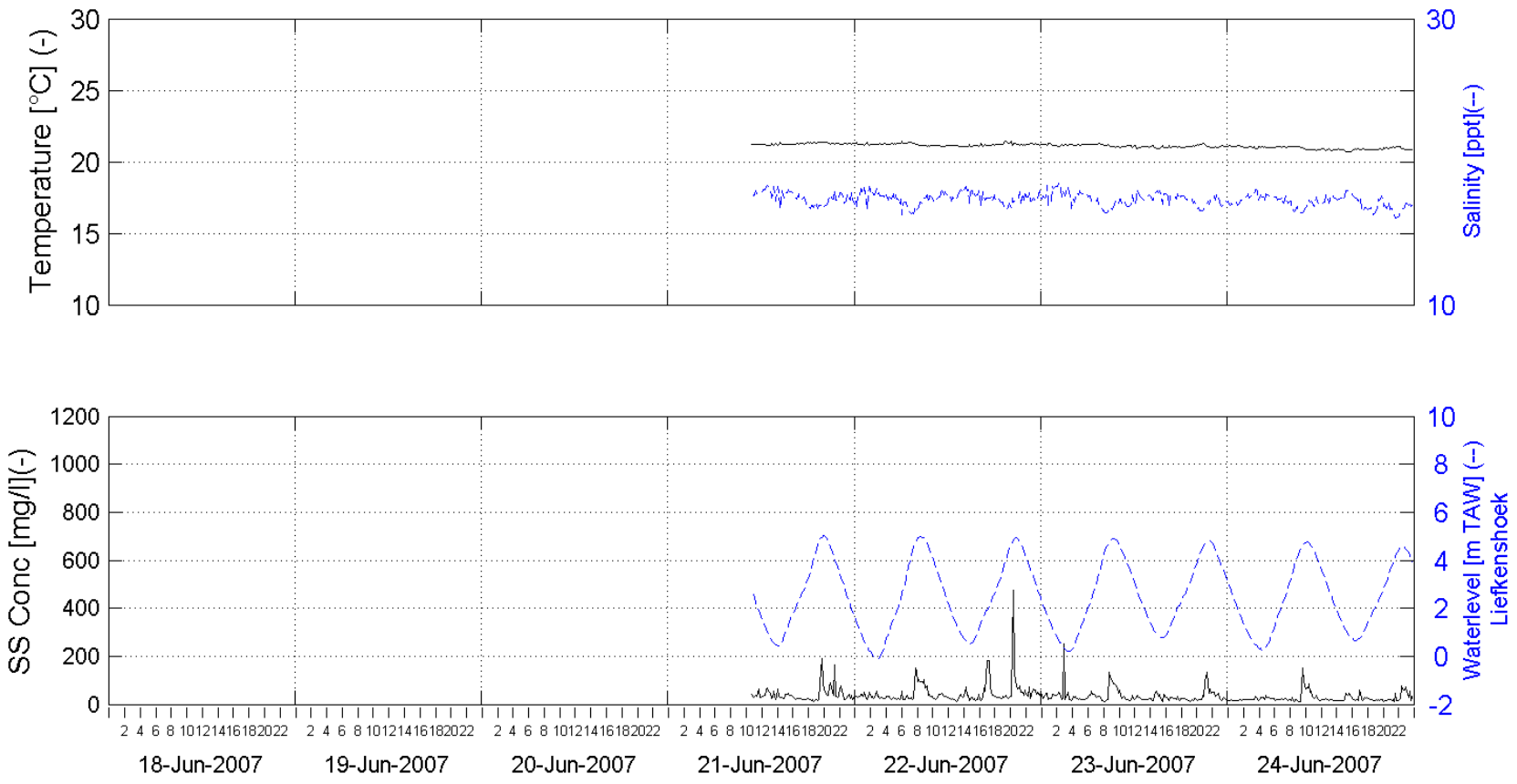
GEMS International

I/RA/11283/07.092/MSA

B.3 P&O 2 (S-ENTRANCE)

11283 - Long-term monitoring DGD - Summer 2007

Week 25 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 3.5m above bottom (-13.5m TAW)

Processed by:

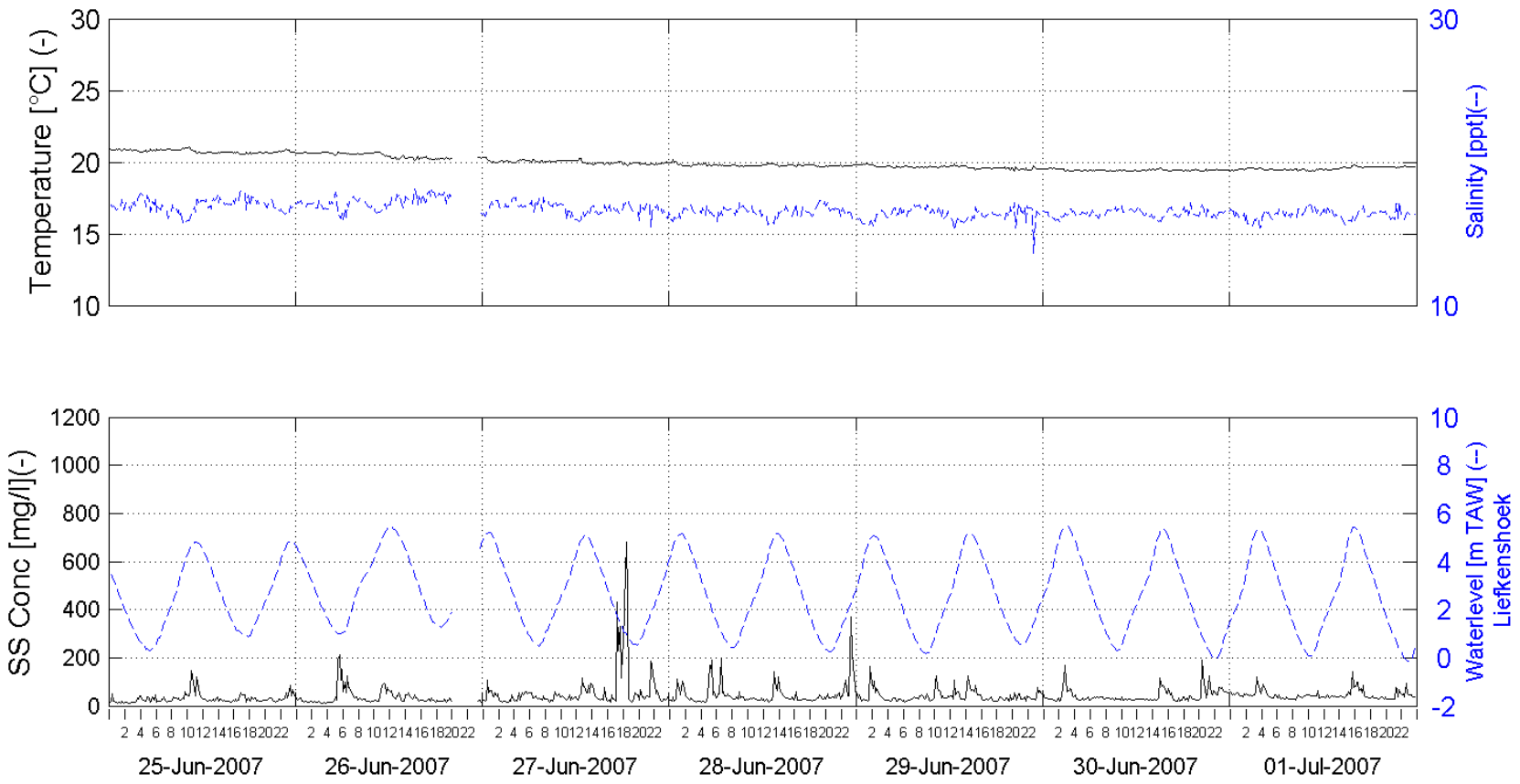
IMDC

In Association with:

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 26 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 3.5m above bottom (-13.5m TAW)

Processed by:

IMDC

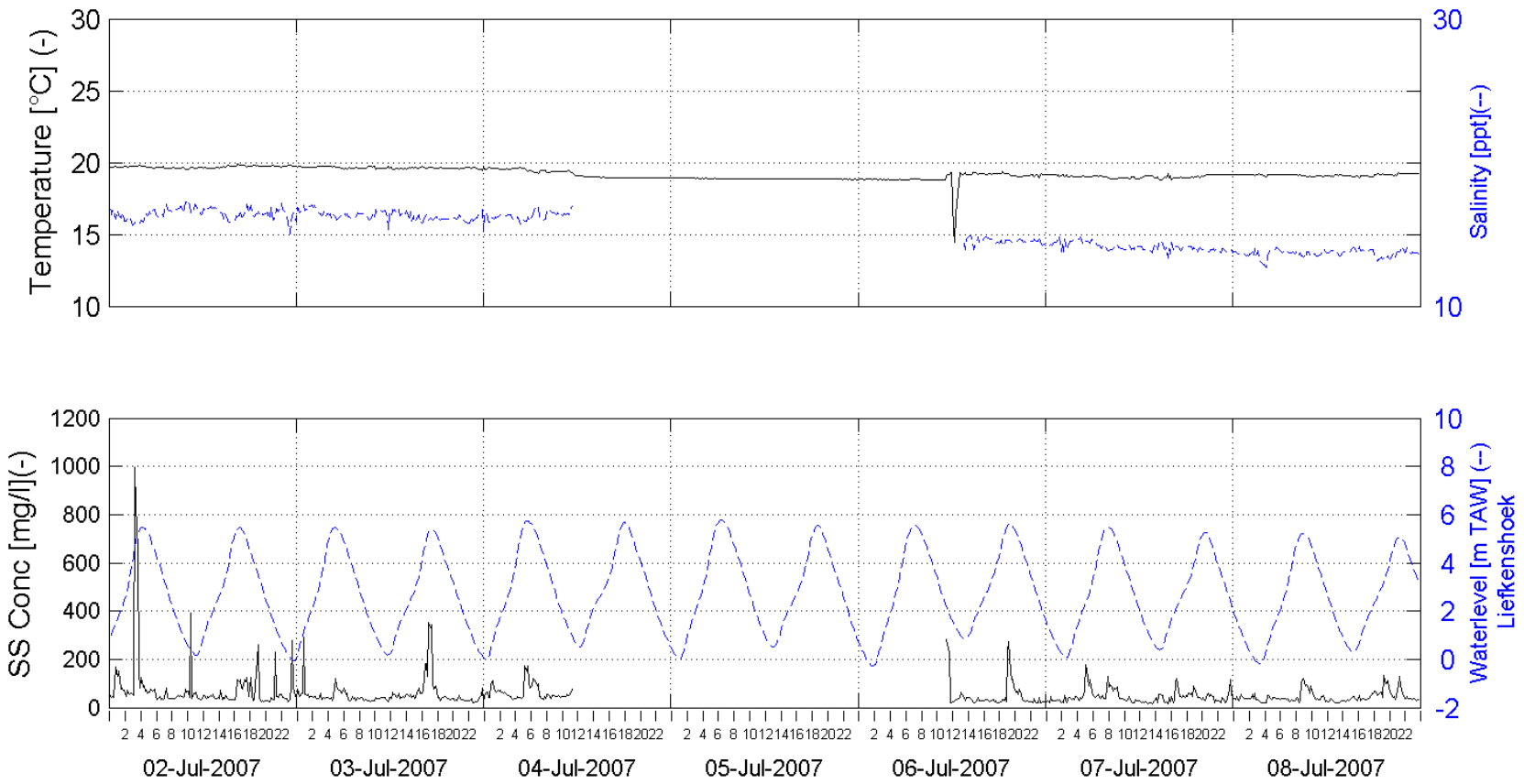
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 27 - 2007



Week series of Salinity, Temperature,
SS Concentration and Tide

Location:

DGD S-ENTRANCE 3.5m above bottom (-13.5m TAW)

Processed by:

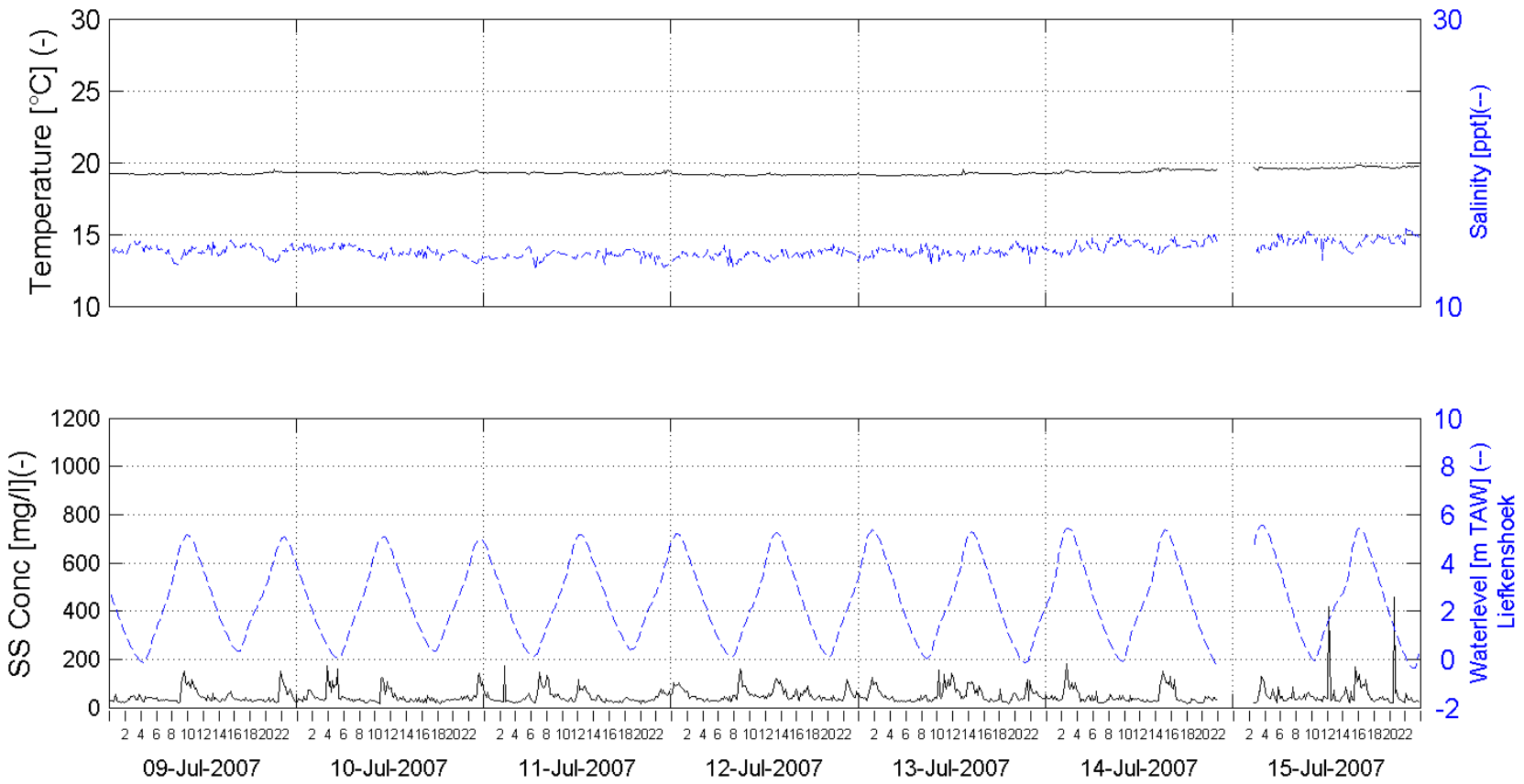
IMDC

In Association with:

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 28 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 3.5m above bottom (-13.5m TAW)

Processed by:

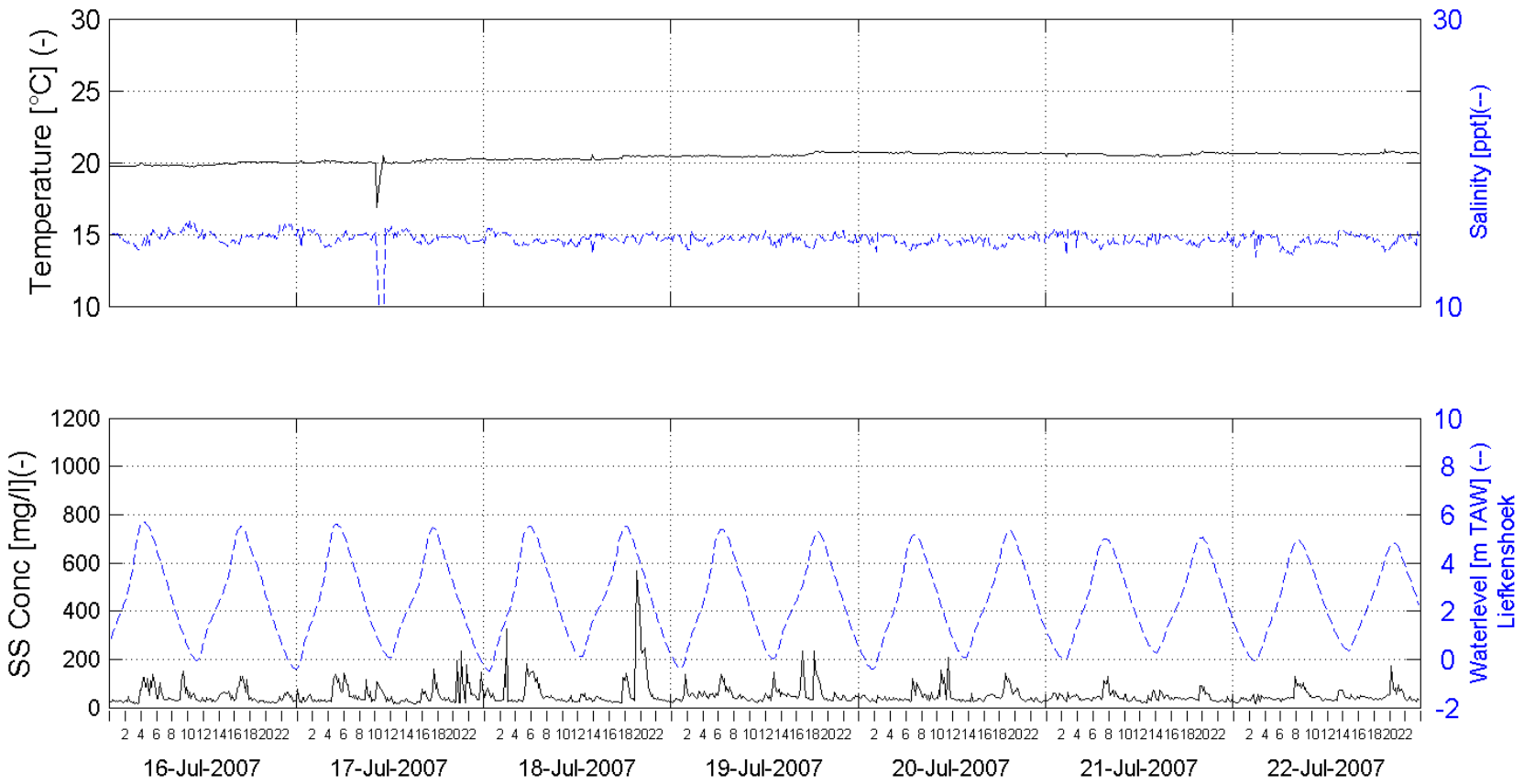
IMDC

In Association with:

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 29 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 3.5m above bottom (-13.5m TAW)

Processed by:

IMDC

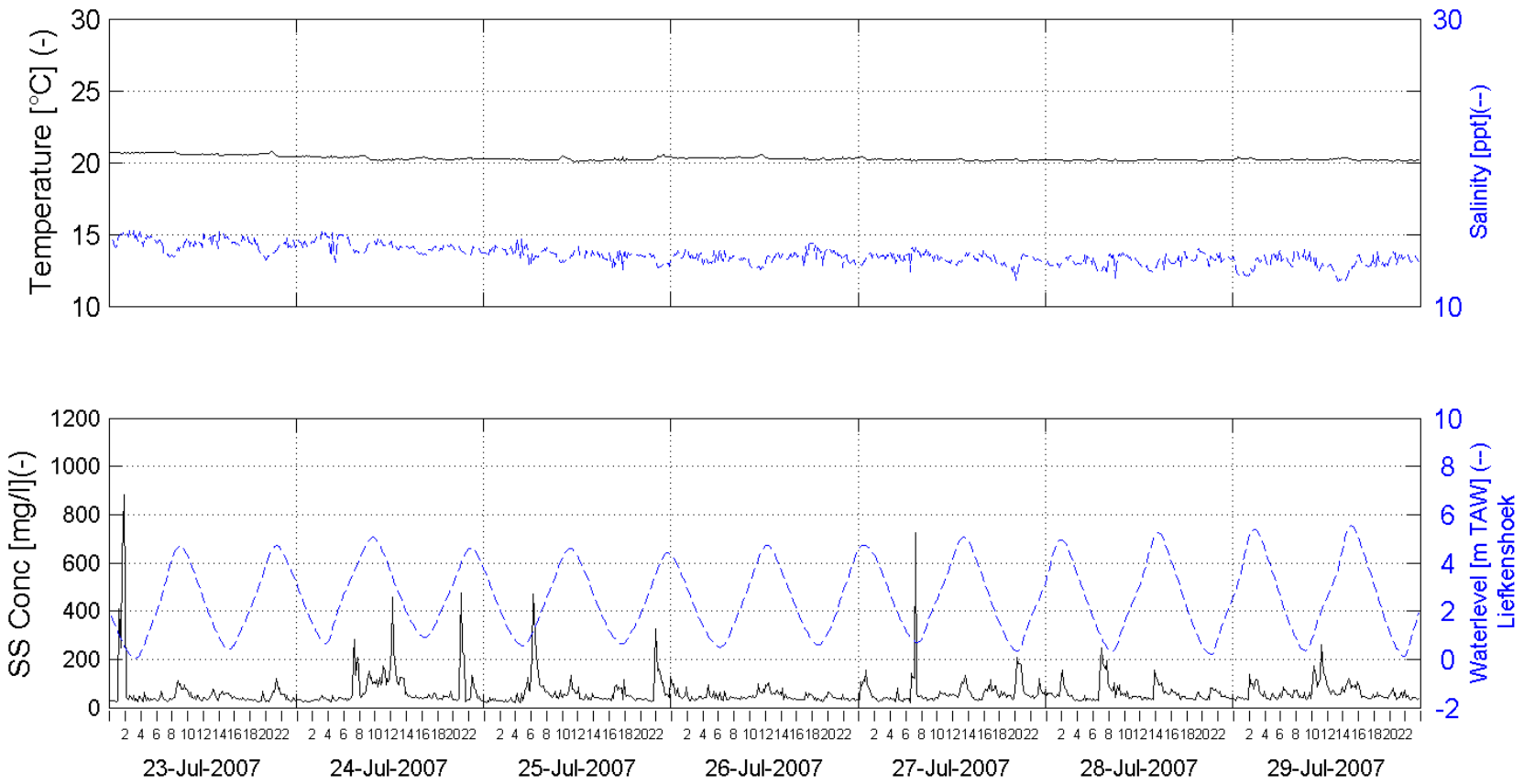
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 30 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 3.5m above bottom (-13.5m TAW)

Processed by:

IMDC

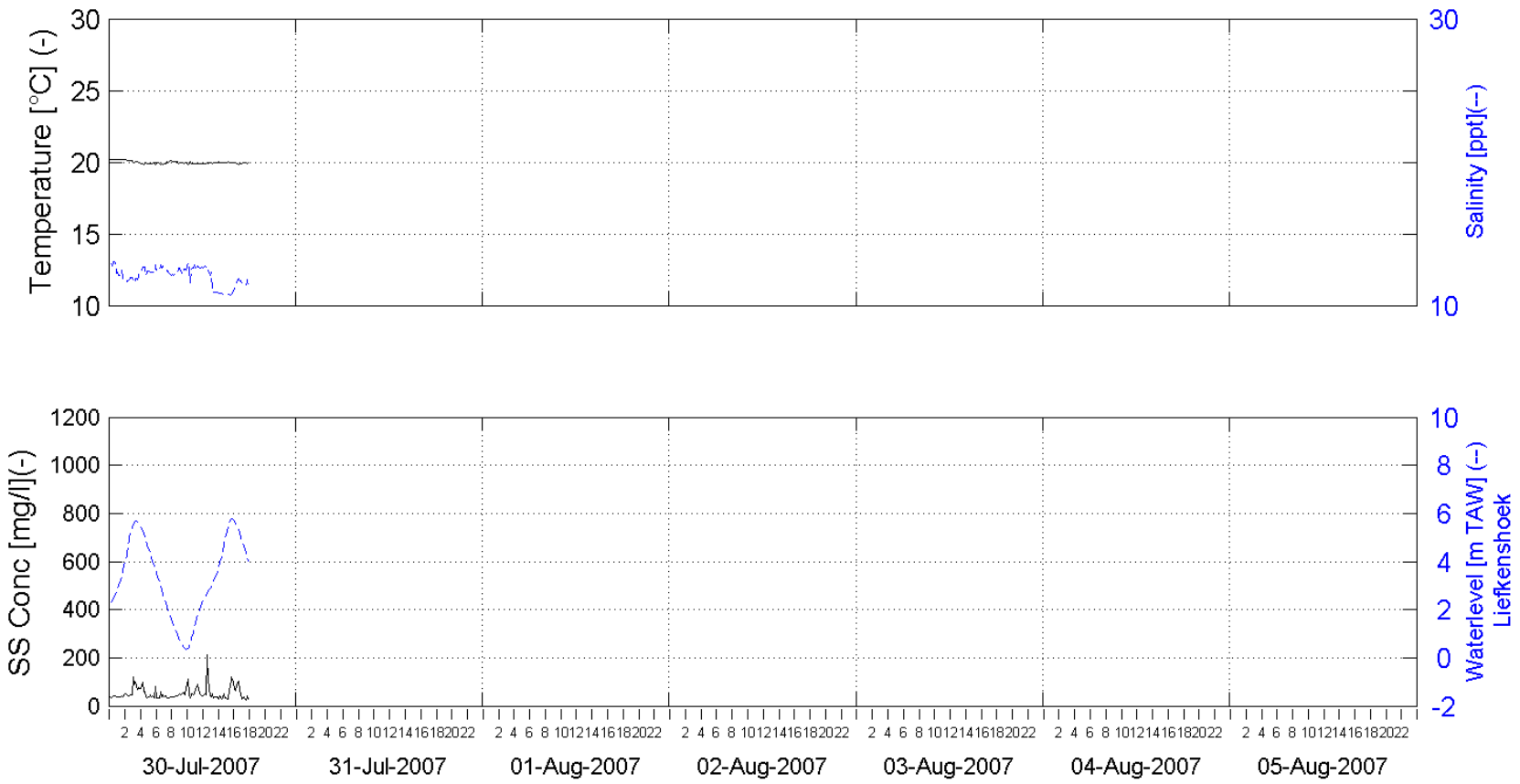
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 31 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 3.5m above bottom (-13.5m TAW)

Processed by:

IMDC

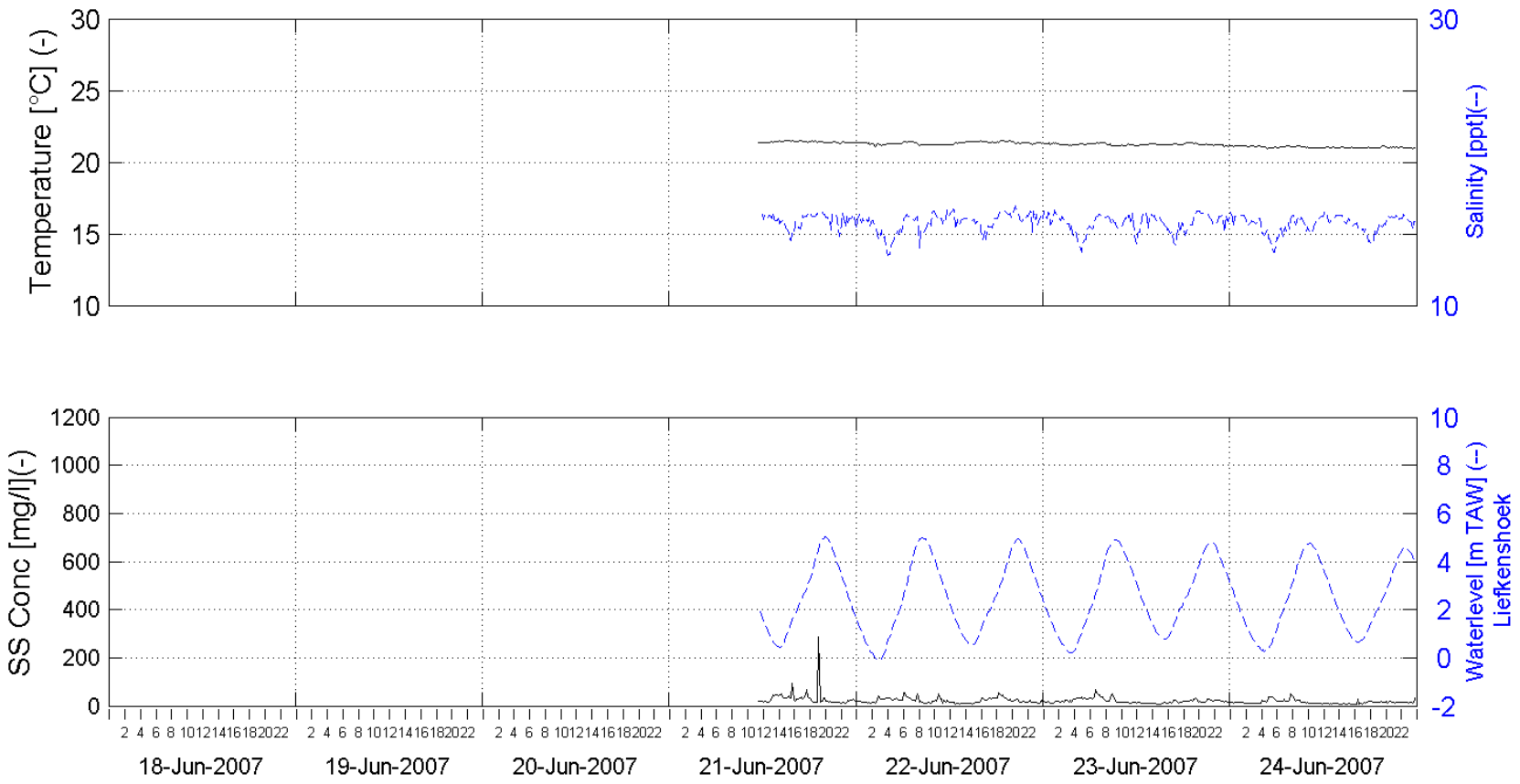
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 25 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 14.5m above bottom (-2.5m TAW)

Processed by:

IMDC

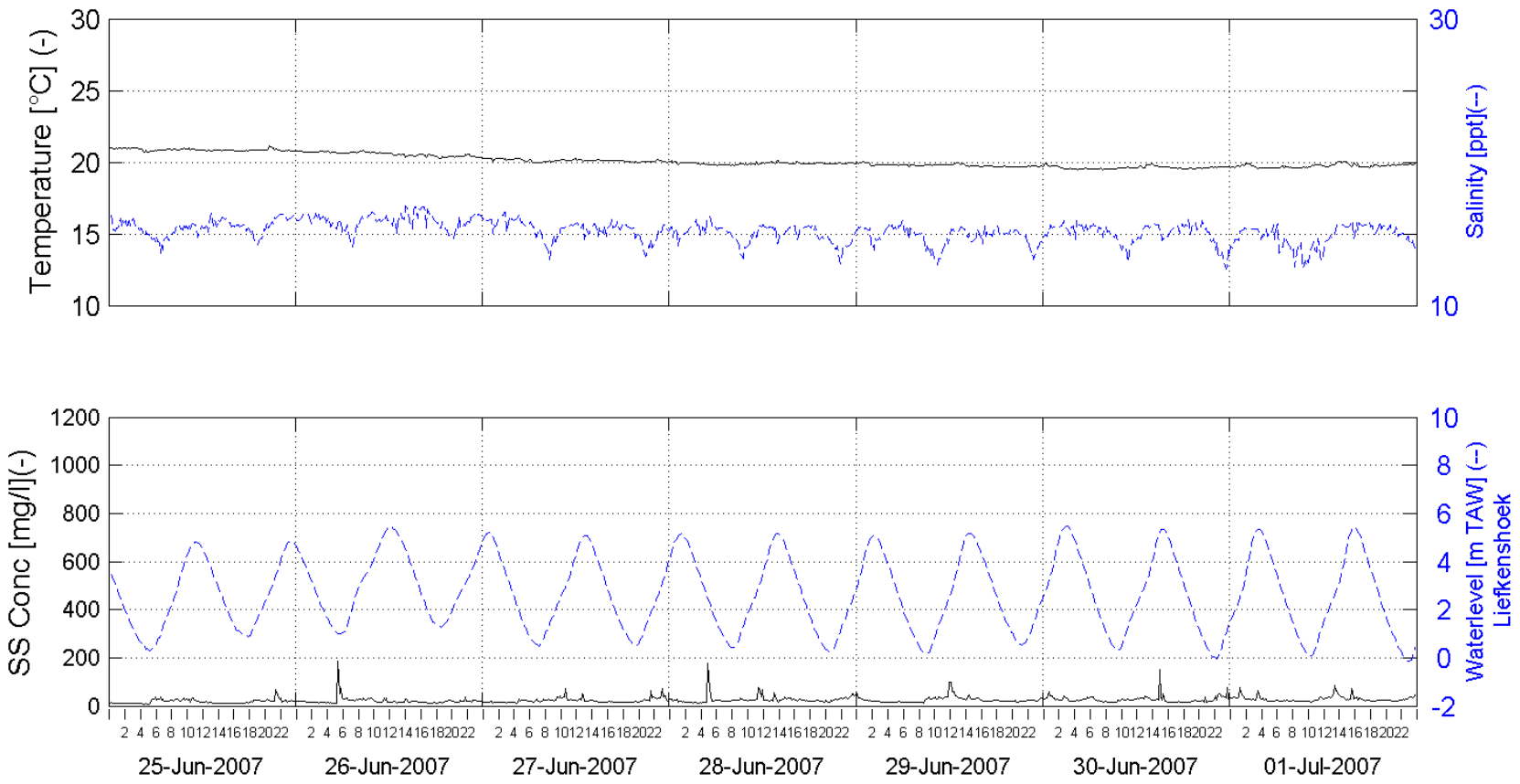
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 26 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 14.5m above bottom (-2.5m TAW)

Processed by:

IMDC

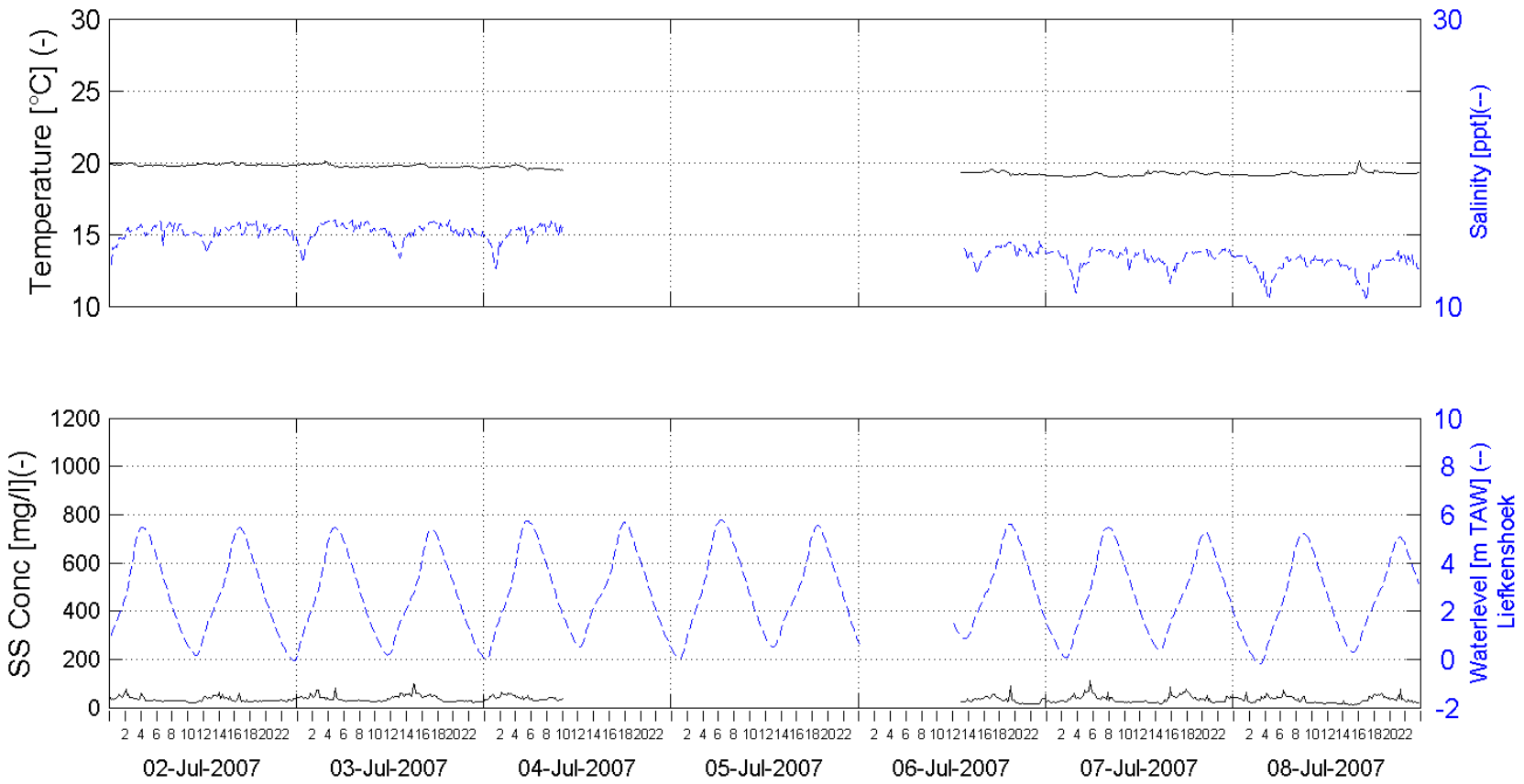
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 27 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 14.5m above bottom (-2.5m TAW)

Processed by:

IMDC

In Association with:

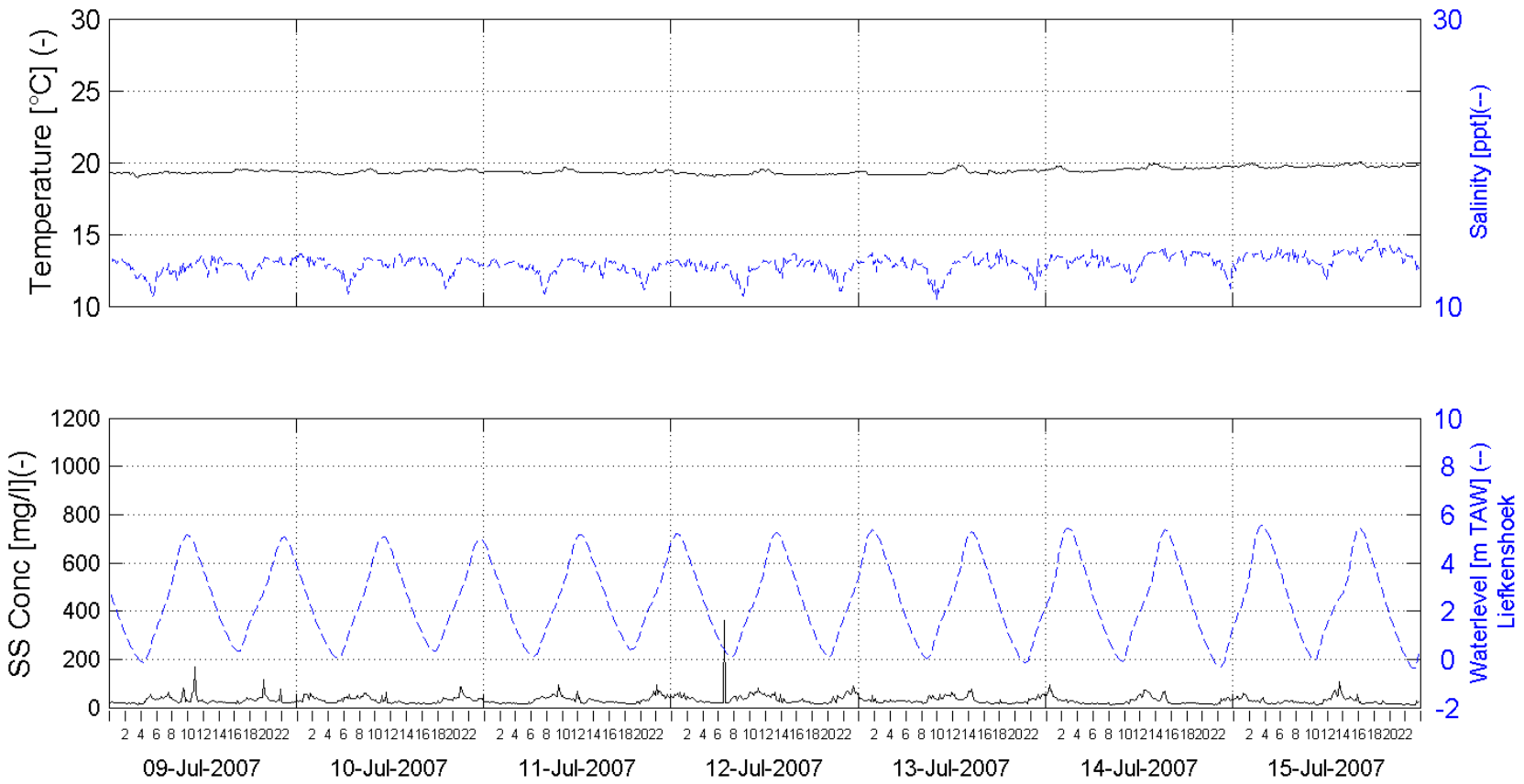
GEMS International

w.l | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 28 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 14.5m above bottom (-2.5m TAW)

Processed by:

IMDC

In Association with:

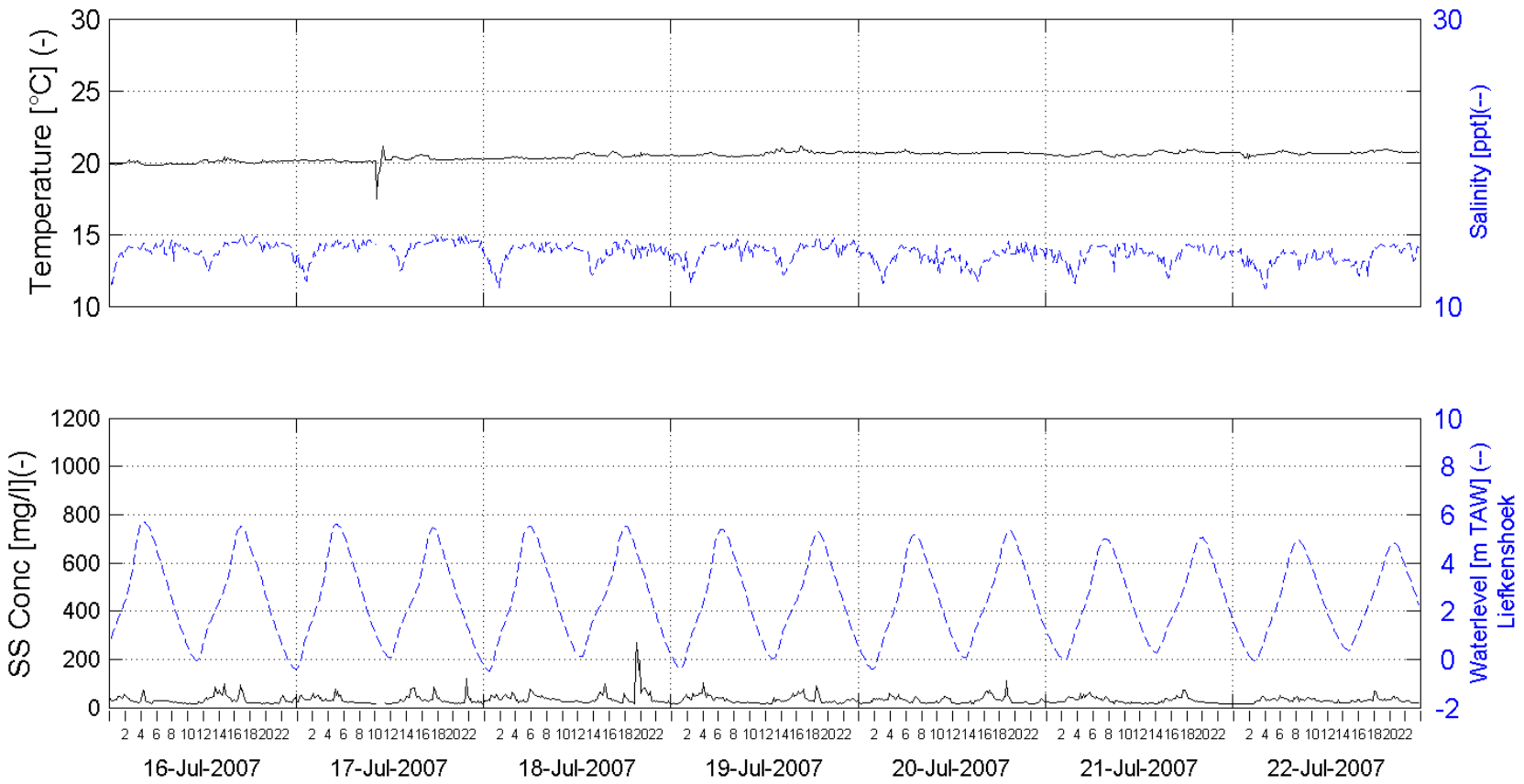
GEMS International

wl | delft hydraulics

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 29 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 14.5m above bottom (-2.5m TAW)

Processed by:

IMDC

In Association with:

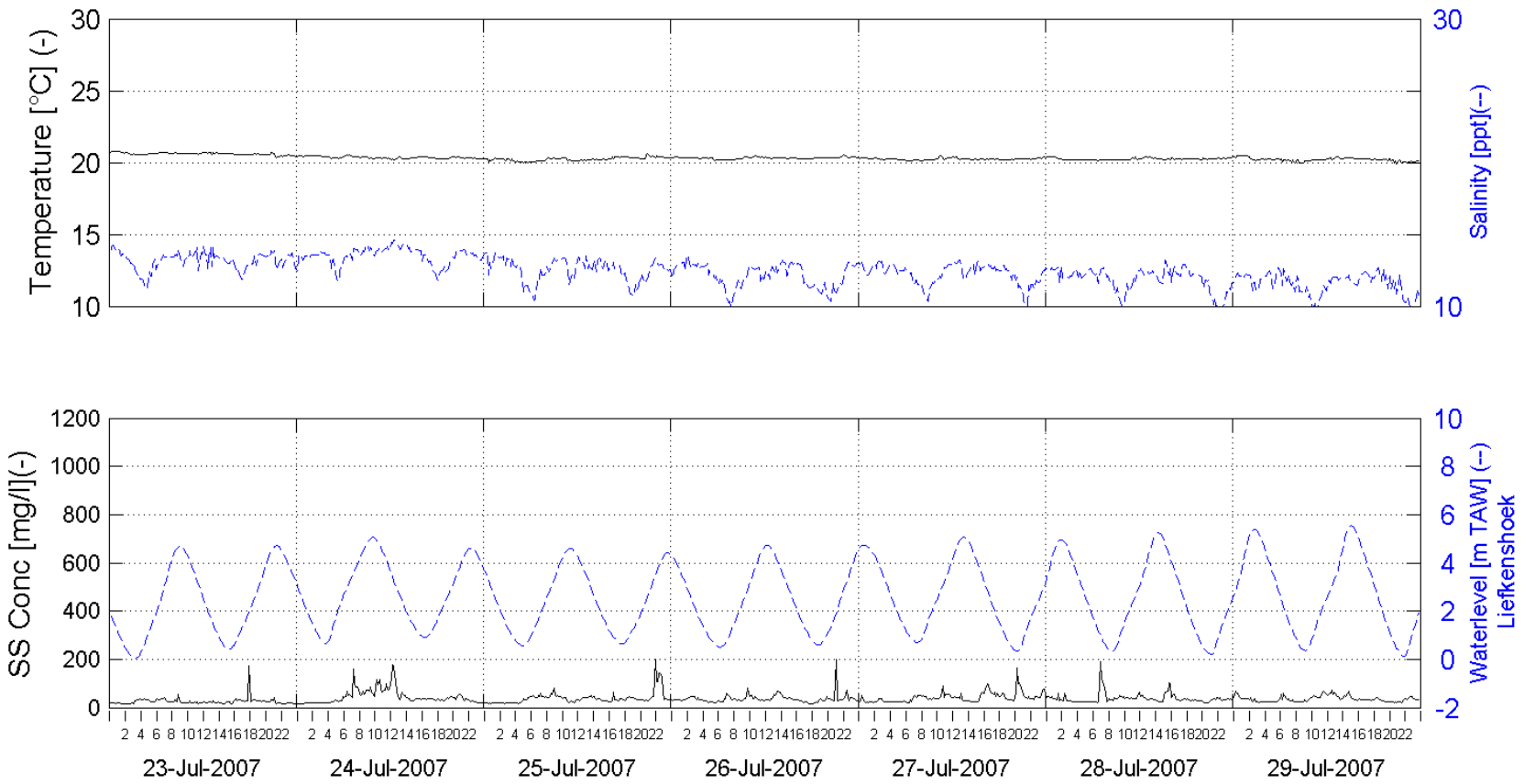
WL | delft hydraulics

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 30 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 14.5m above bottom (-2.5m TAW)

Processed by:

IMDC

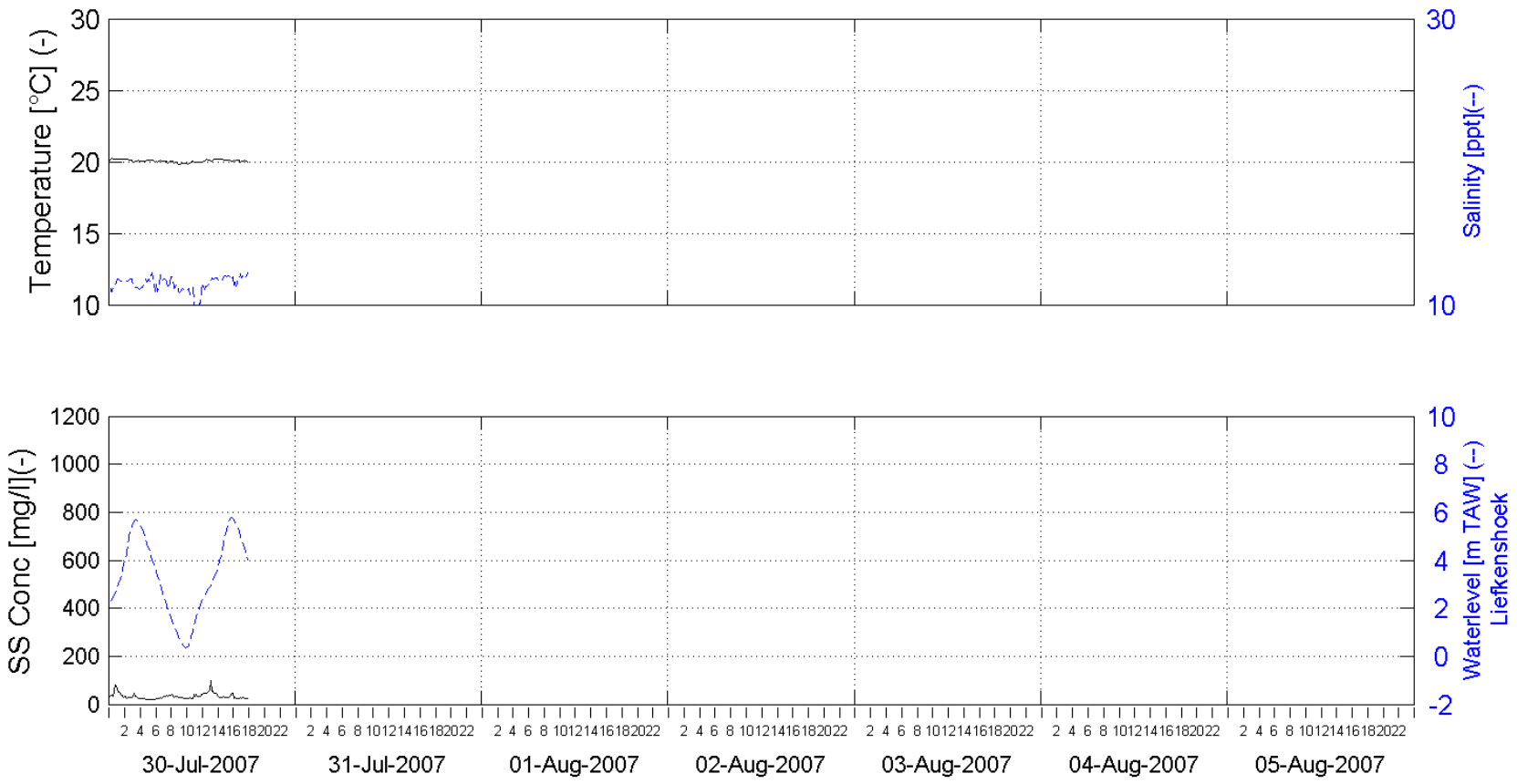
In Association with:

GEMS International

I/RA/11283/07.092/MSA

11283 - Long-term monitoring DGD - Summer 2007

Week 31 - 2007



Week series of Salinity, Temperature, SS Concentration and Tide

Location:

DGD S-ENTRANCE 14.5m above bottom (-2.5m TAW)

Processed by:

IMDC

In Association with:

GEMS International

I/RA/11283/07.092/MSA

APPENDIX C.

HCBS2 REPORTS

Report	Description
Ambient Conditions Lower Sea Scheldt	
5.3	Overview of ambient conditions in the river Scheldt – January-June 2006 (I/RA/11291/06.088/MSA)
5.4	Overview of ambient conditions in the river Scheldt – July-December 2006 (I/RA/11291/06.089/MSA)
~~5.5~~	~~Overview of ambient conditions in the river Scheldt : RCM-9 buoy 84 & 97 (1/1/2007 - 31/3/2007) (I/RA/11291/06.090/MSA)~~*
5.6	Analysis of ambient conditions 21/09/05 - 31/3/2007 (I/RA/11291/06.091/MSA)
Calibration	
6.1	Winter Calibration (I/RA/11291/06.092/MSA)
6.2	Summer Calibration and Final Report (I/RA/11291/06.093/MSA)
Through tide Measurements Winter 2006	
7.1	21/3 Scheldewacht – Deurganckdok – Salinity Distribution (I/RA/11291/06.094/MSA)
7.2	22/3 Parel 2 – Deurganckdok (I/RA/11291/06.095/MSA)
7.3	22/3 Laure Marie – Liefkenshoek (I/RA/11291/06.096/MSA)
7.4	23/3 Parel 2 – Schelle (I/RA/11291/06.097/MSA)
7.5	23/3 Laure Marie – Deurganckdok (I/RA/11291/06.098/MSA)
7.6	23/3 Veremans Waarde (I/RA/11291/06.099/MSA)
HCBS Near bed continuous monitoring (Frames)	
8.1	Near bed continuous monitoring winter 2006 (I/RA/11291/06.100/MSA)
INSSEV	
9	Settling Velocity - INSSEV summer 2006 (I/RA/11291/06.102/MSA)
Cohesive Sediment	
10	Cohesive sediment properties summer 2006 (I/RA/11291/06.103/MSA)
Through tide Measurements Summer 2006	
11.1	Through Tide Measurement Sediview and Siltprofiler 27/9 Stream - Liefkenshoek (I/RA/11291/06.104/MSA)
11.2	Through Tide Measurement Sediview 27/9 Veremans - Raai K (I/RA/11291/06.105/MSA)
11.3	Through Tide Measurement Sediview and Siltprofiler 28/9 Stream - Raai K (I/RA/11291/06.106/MSA)
11.4	Through Tide Measurement Sediview 28/9 Veremans – Waarde (I/RA/11291/06.107/MSA)
11.5	Through Tide Measurements Sediview 28/9 Parel 2 - Schelle (I/RA/11291/06.108/MSA)
11.6	Through Tide measurement Longitudinal Salinity Distribution 26/9 Scheldewacht – Deurganckdok (I/RA/11291/06.161/MSA)
Analysis	
12	Report concerning the presence of HCBS layers in the Scheldt river (I/RA/11291/06.109/MSA)

* Report 5.5 will be handled in report 3.1. Boundary conditions: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/06.127/MSA) including HCBS 2 report 5.5 (Deurganckdok).

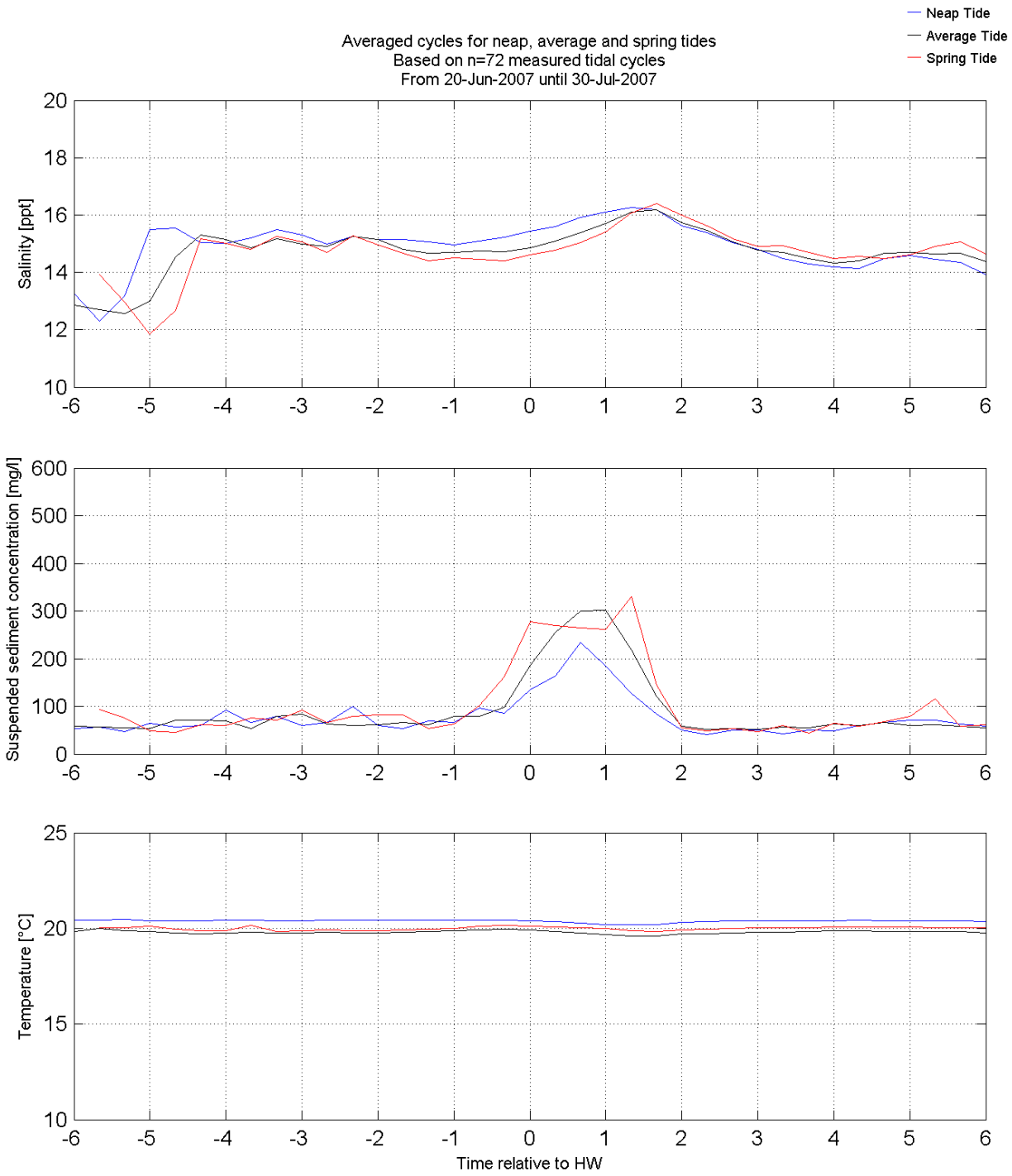
APPENDIX D.

AVERAGE TIDAL CYCLES

D.1 Local parameters

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS-3A
	Location: N-ENTRANCE bottom



Absolute Parameters for averaged tidal cycle

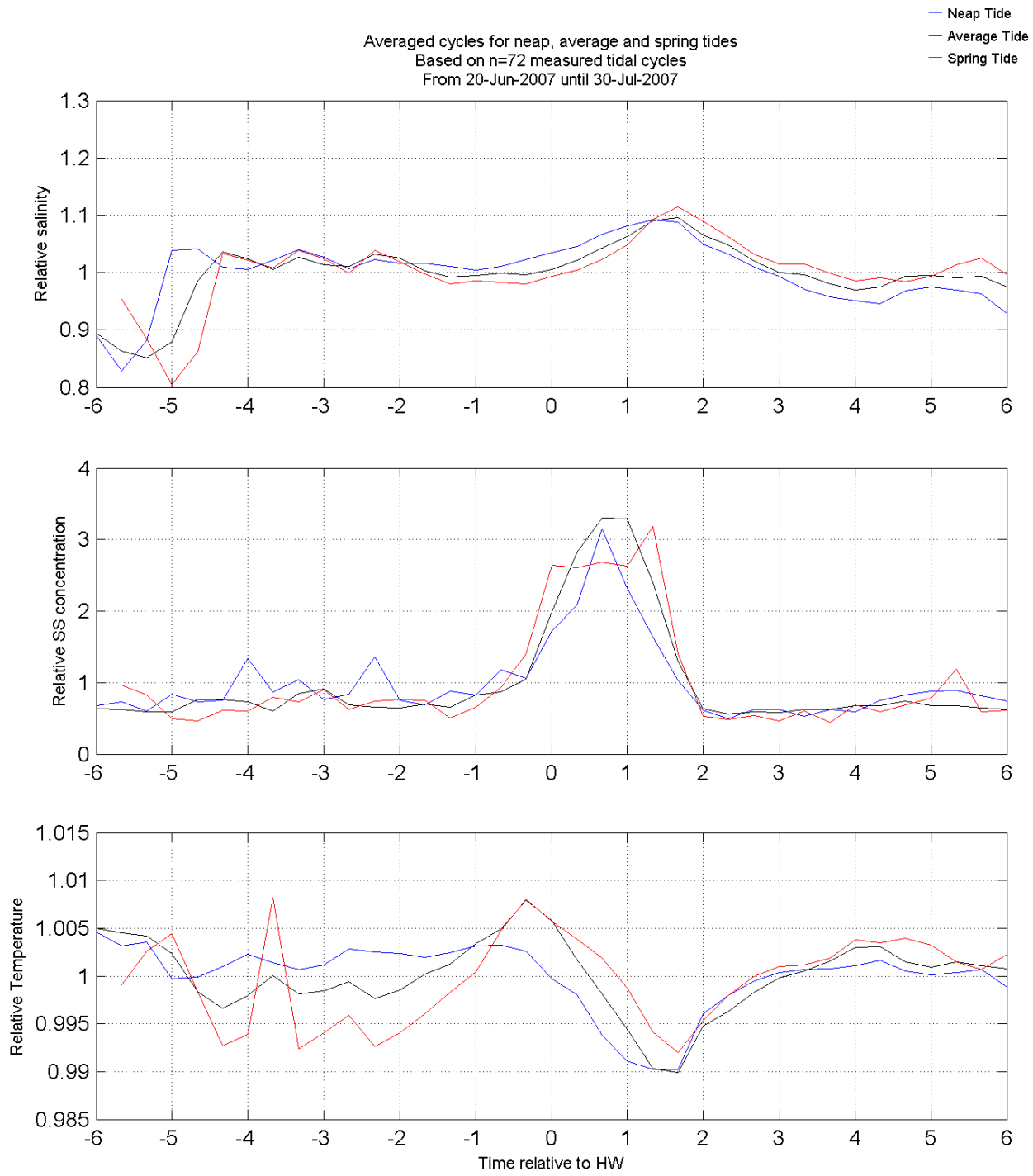
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS-3A
	Location: N-ENTRANCE bottom



Relative Parameters for averaged tidal cycle

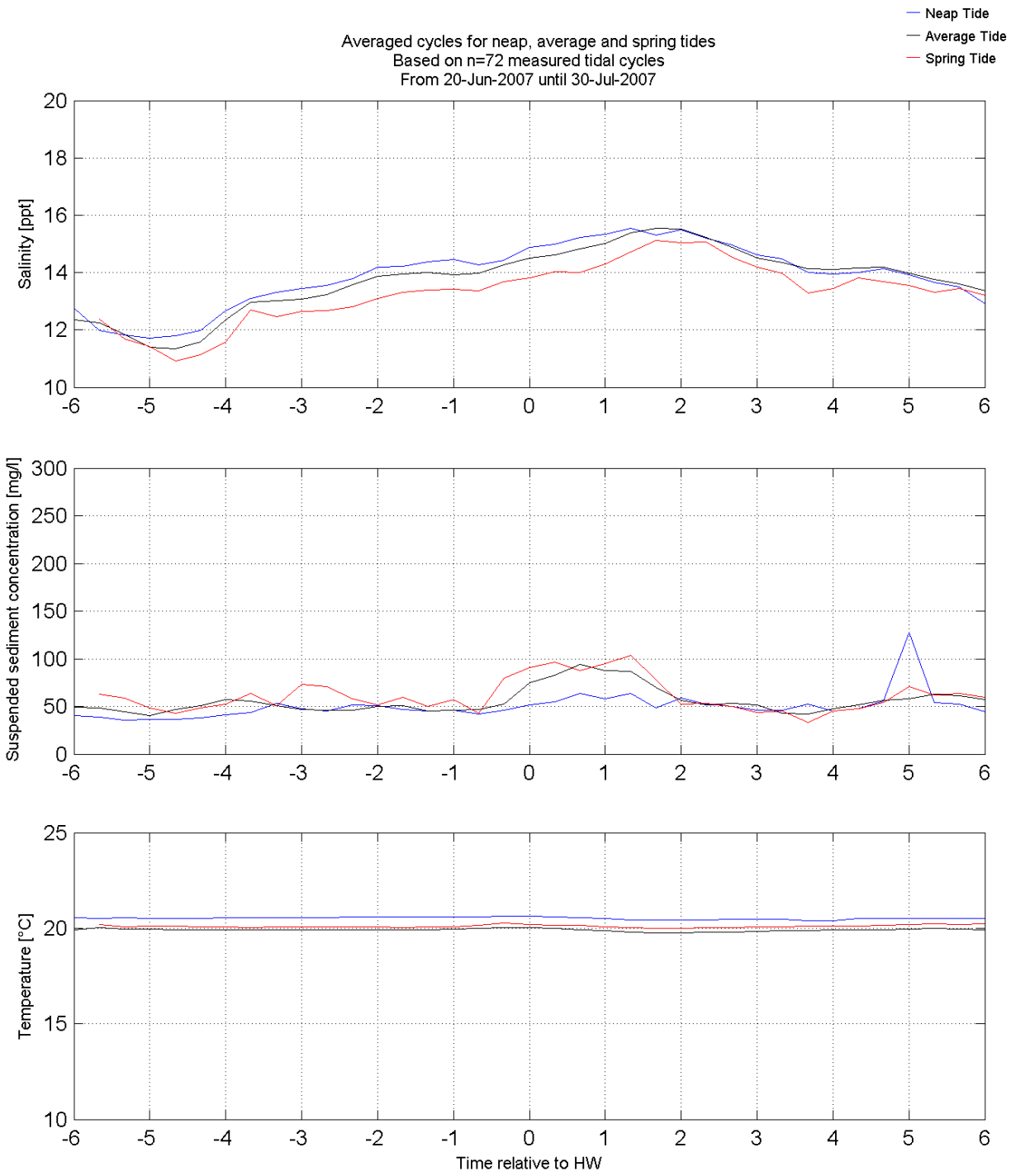
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS-3A
	Location: N-ENTRANCE top



Absolute Parameters for averaged tidal cycle

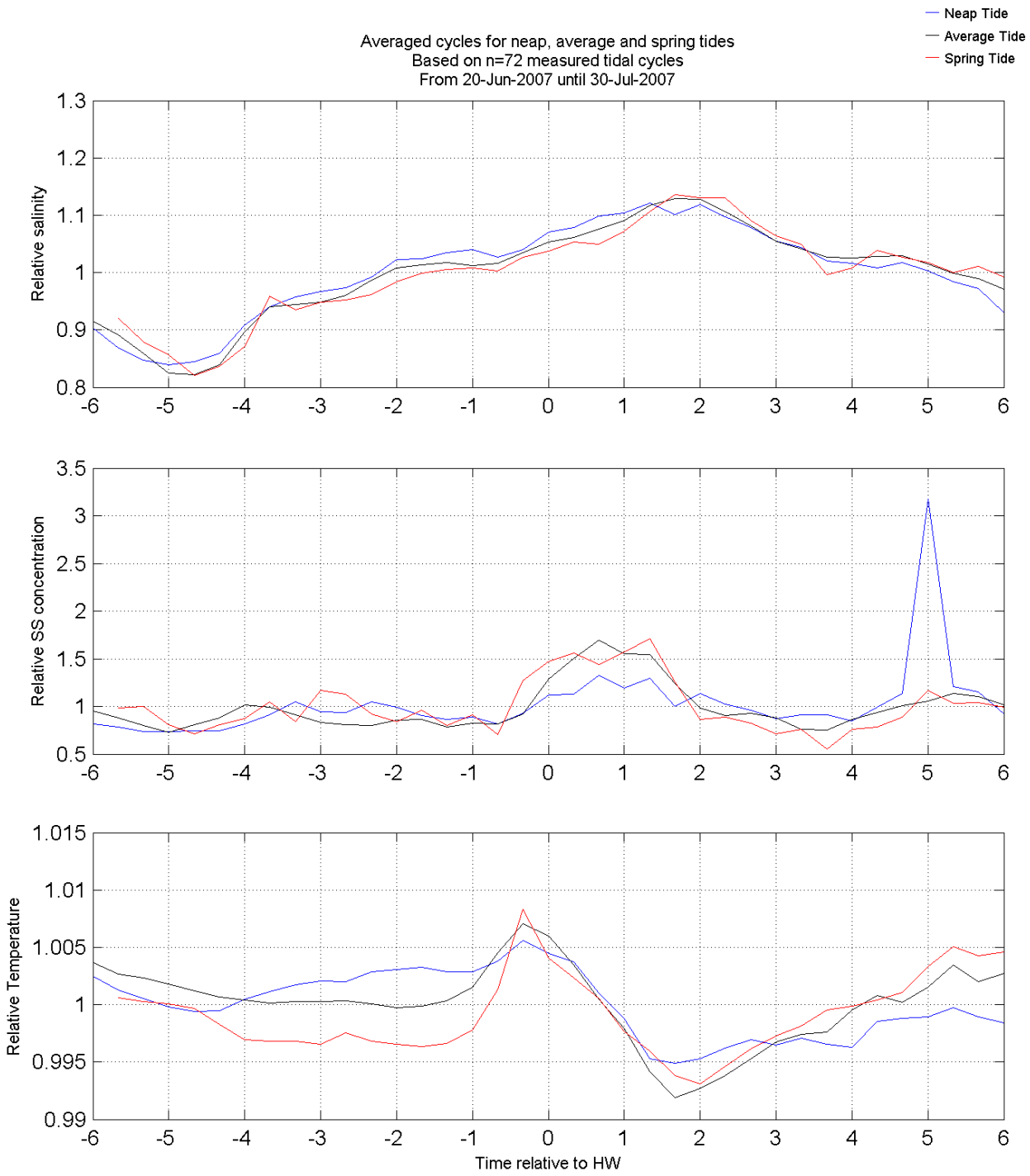
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS-3A
	Location: N-ENTRANCE top



Relative Parameters for averaged tidal cycle

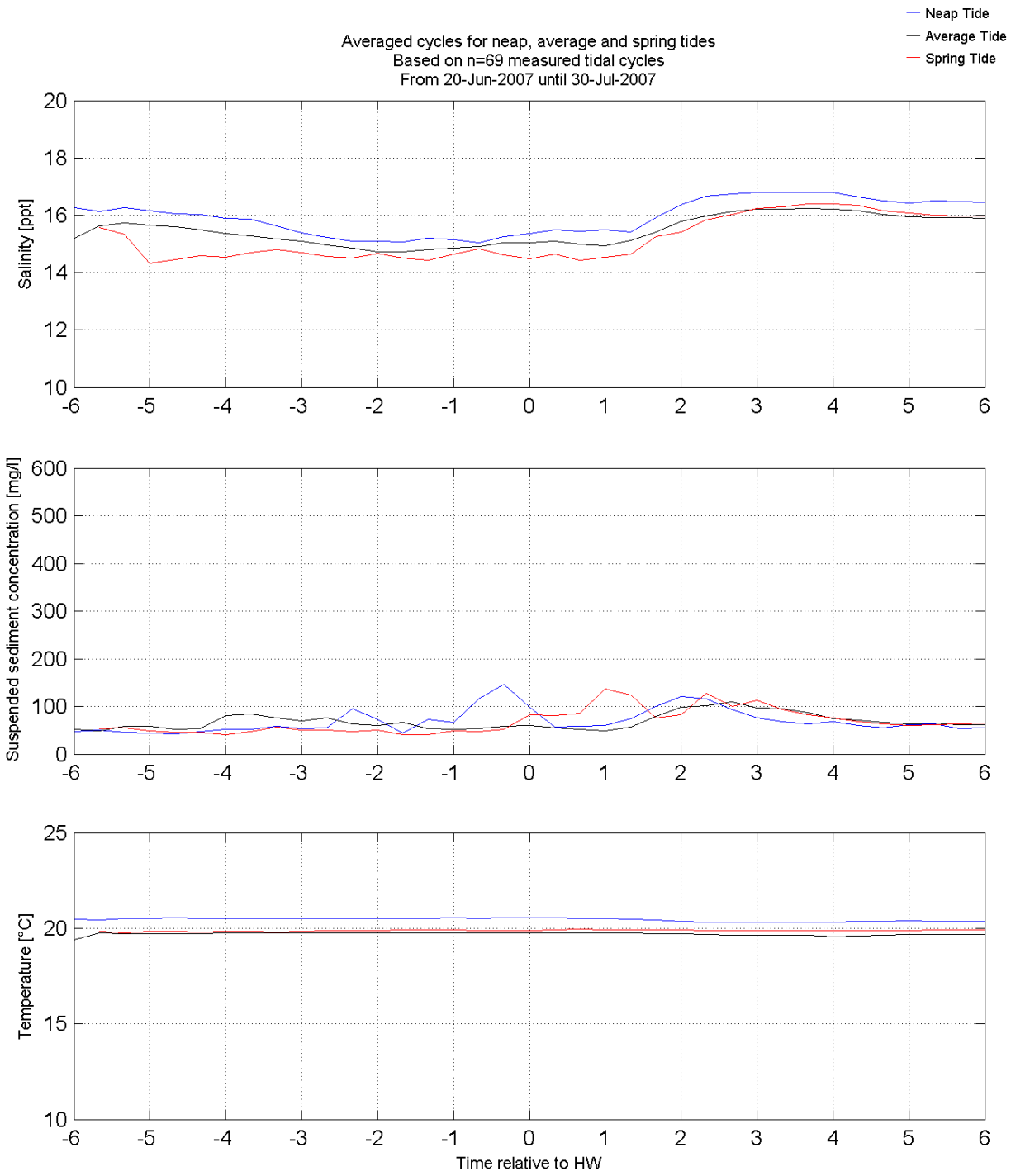
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS-3A
	Location: S-BACK bottom



Absolute Parameters for averaged tidal cycle

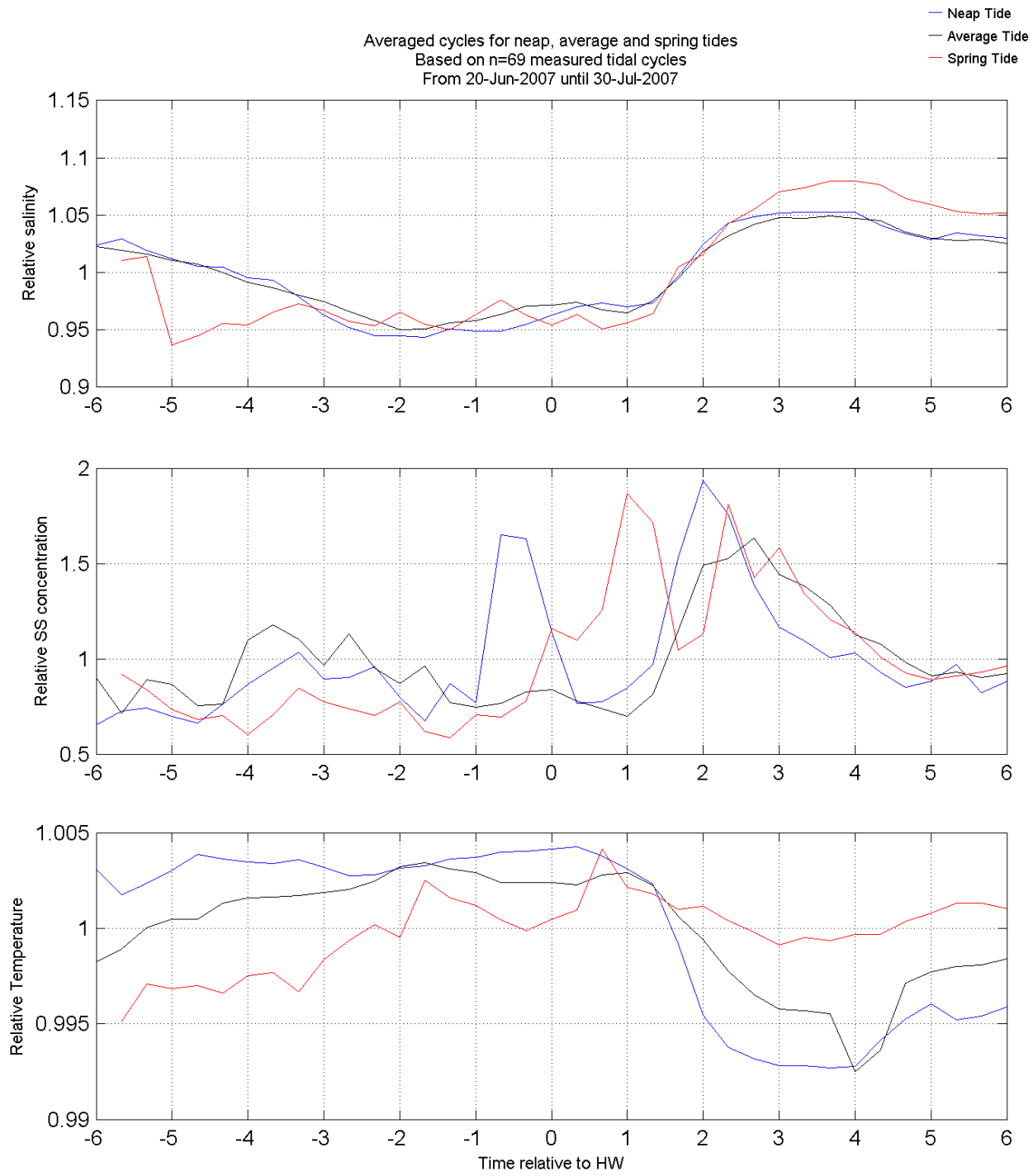
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS-3A
	Location: S-BACK bottom



Relative Parameters for averaged tidal cycle

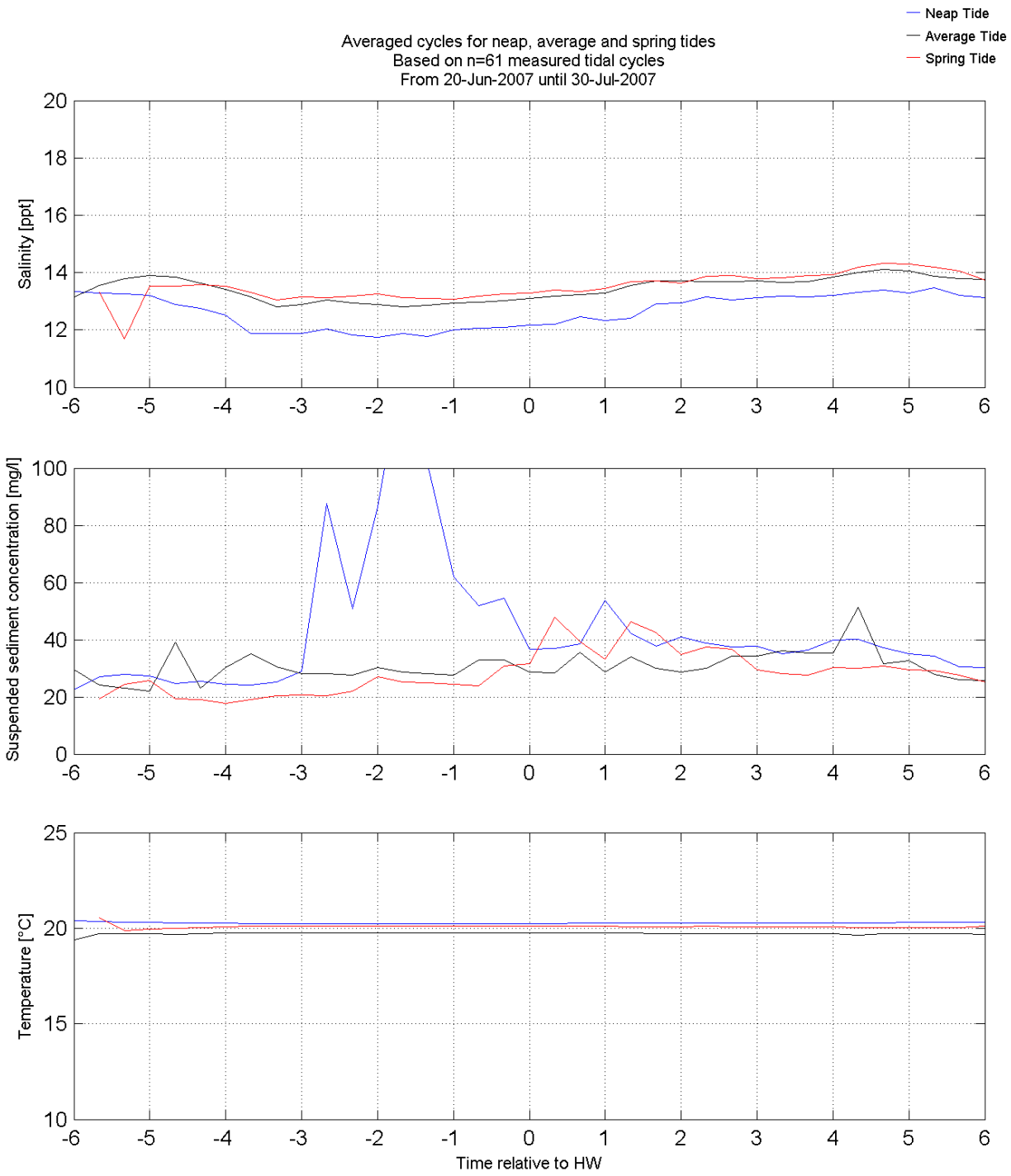
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS-3A
	Location: S-BACK top



Absolute Parameters for averaged tidal cycle

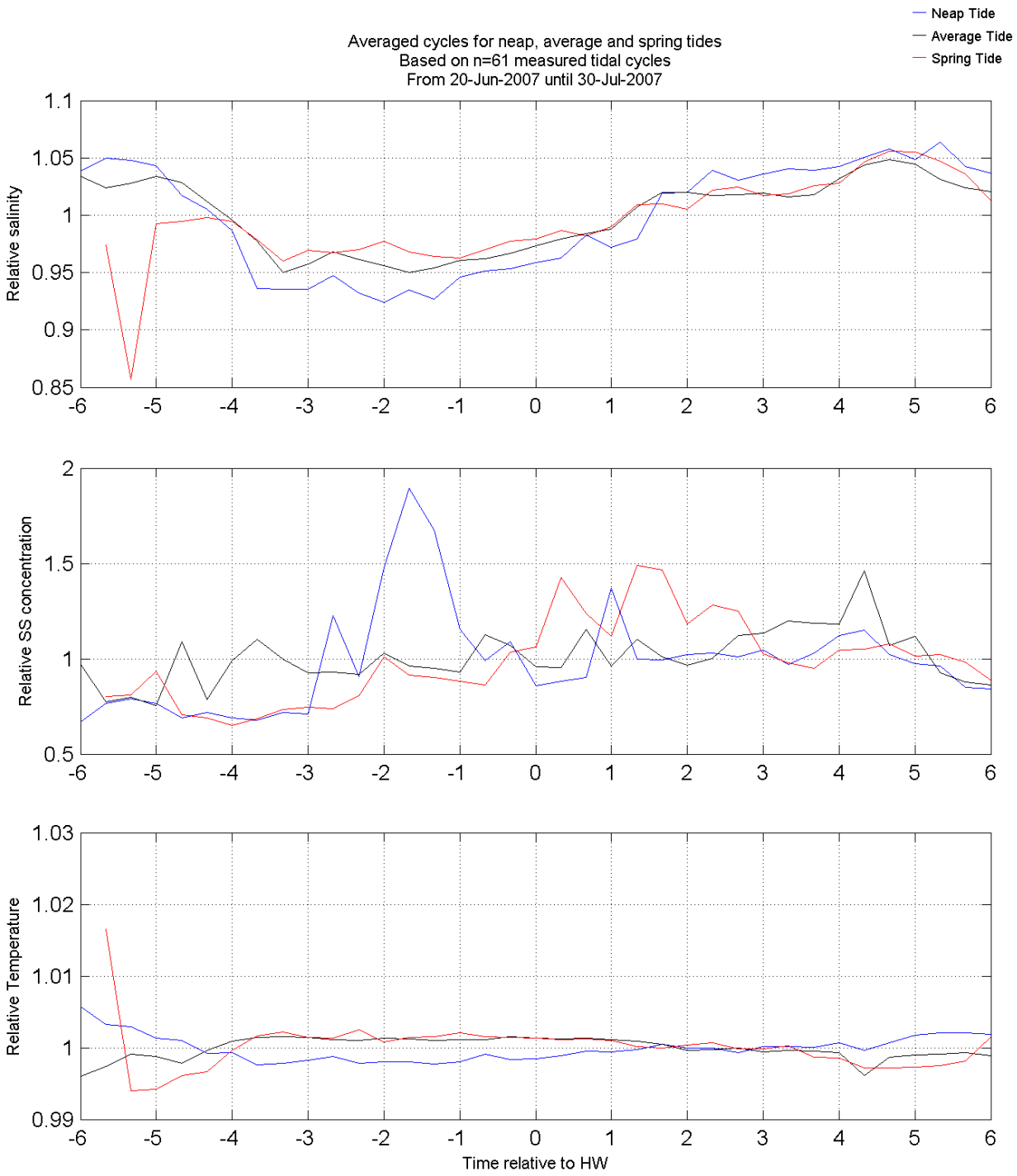
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS-3A
	Location: S-BACK top



Relative Parameters for averaged tidal cycle

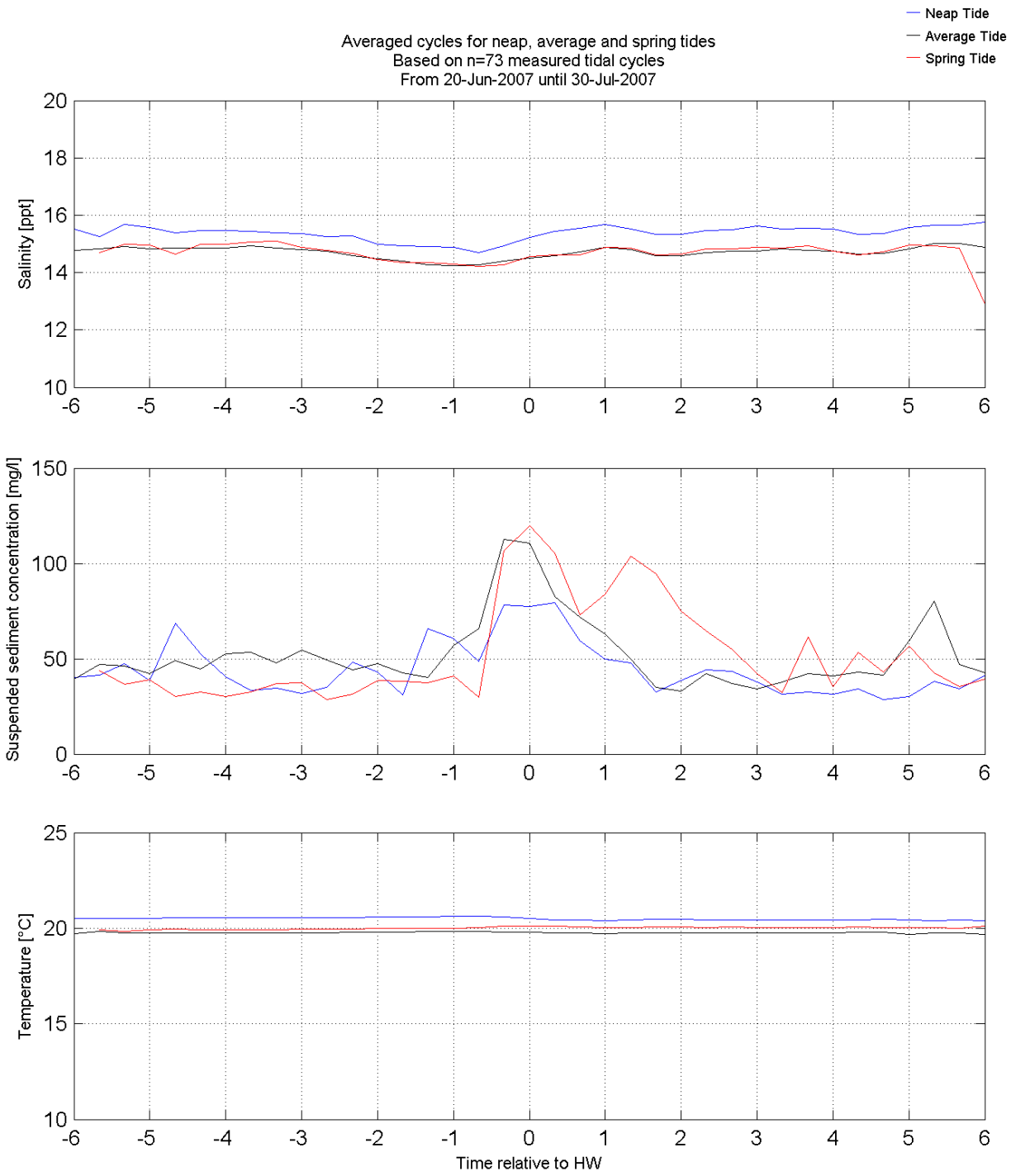
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS-3A
	Location: S-ENTRANCE bottom



Absolute Parameters for averaged tidal cycle

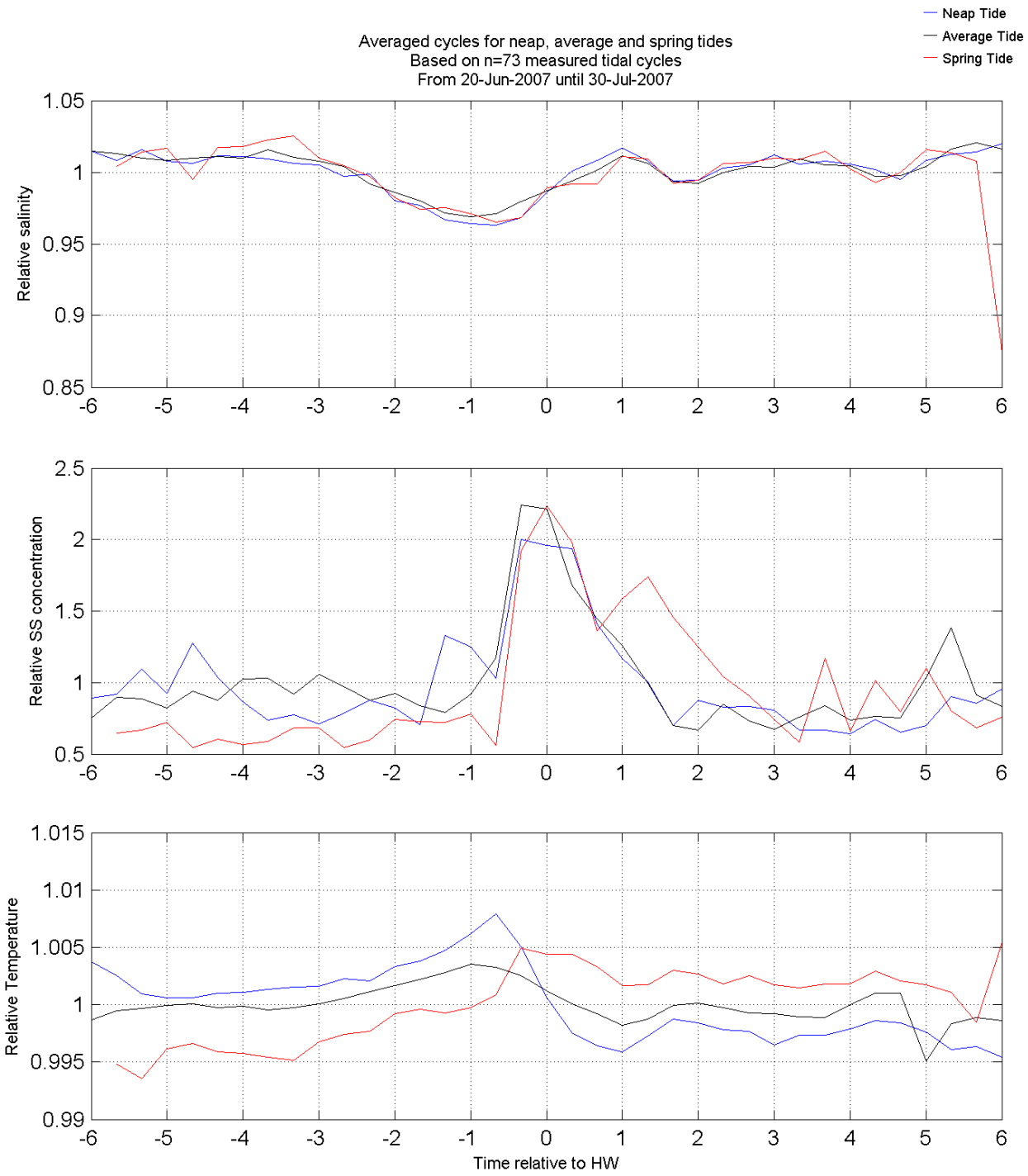
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS-3A
	Location: S-ENTRANCE bottom



Relative Parameters for averaged tidal cycle

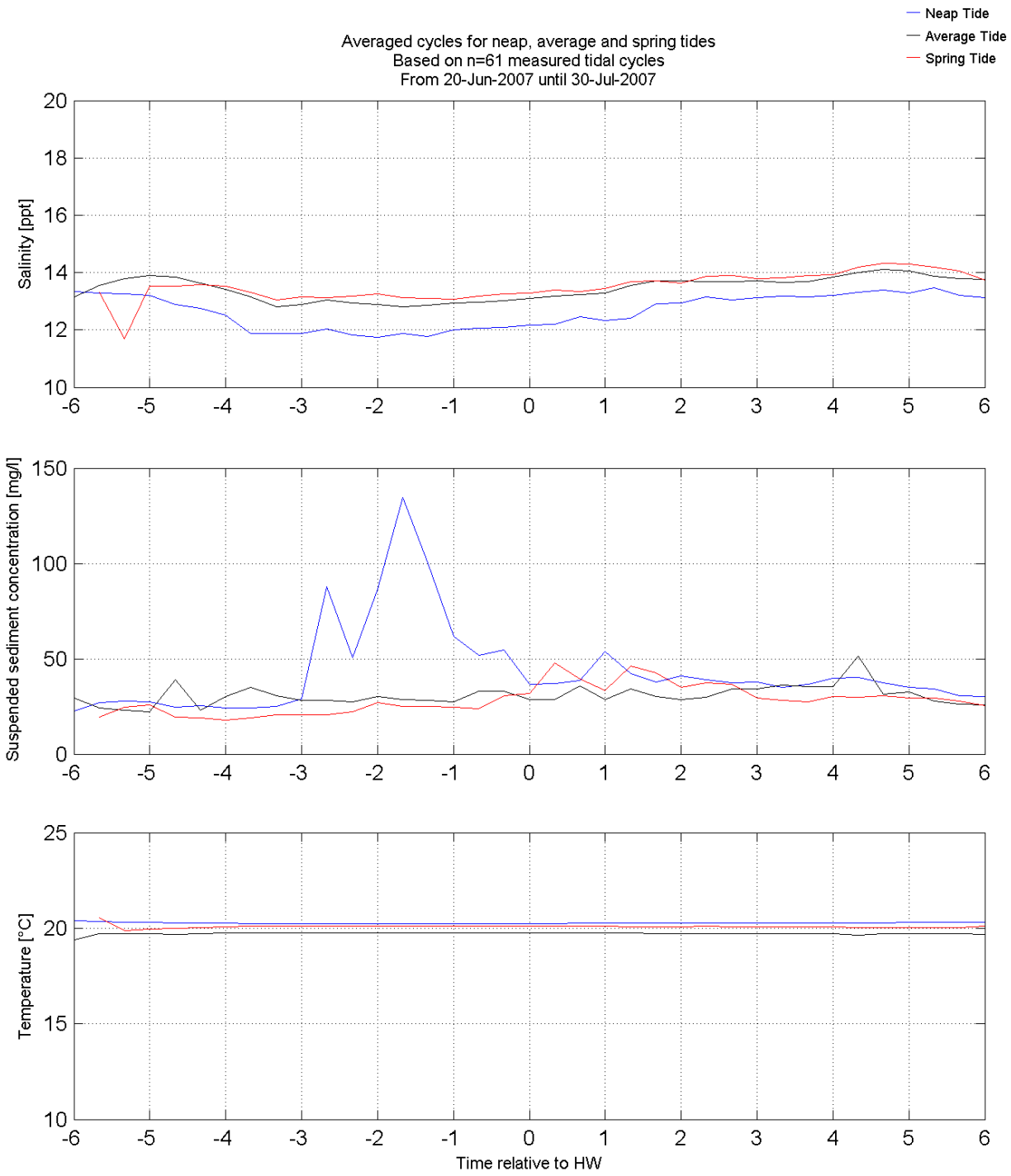
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS-3A
	Location: S-ENTRANCE top



Absolute Parameters for averaged tidal cycle

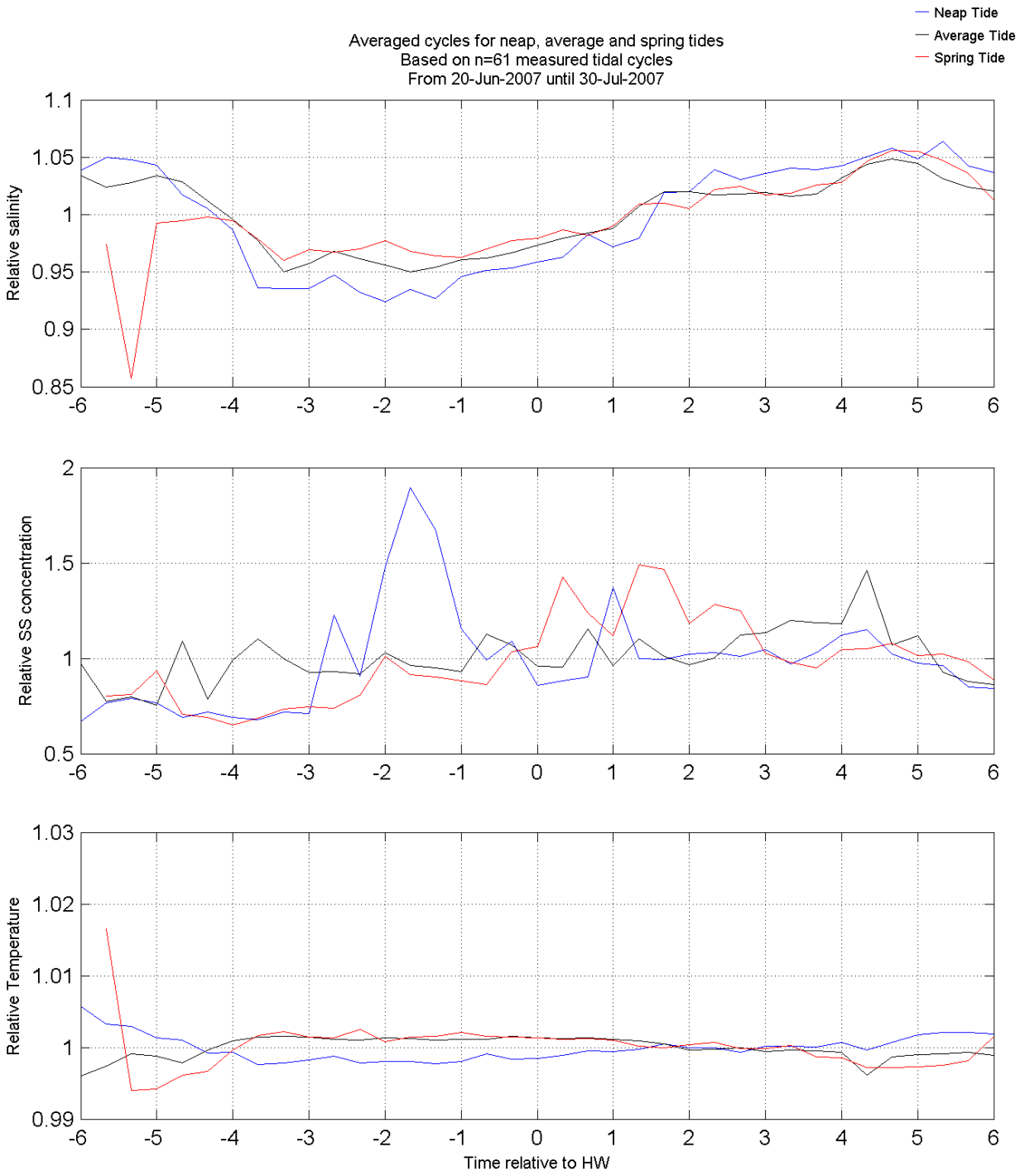
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS-3A
	Location: S-ENTRANCE top



Relative Parameters for averaged tidal cycle

Data Processed by:

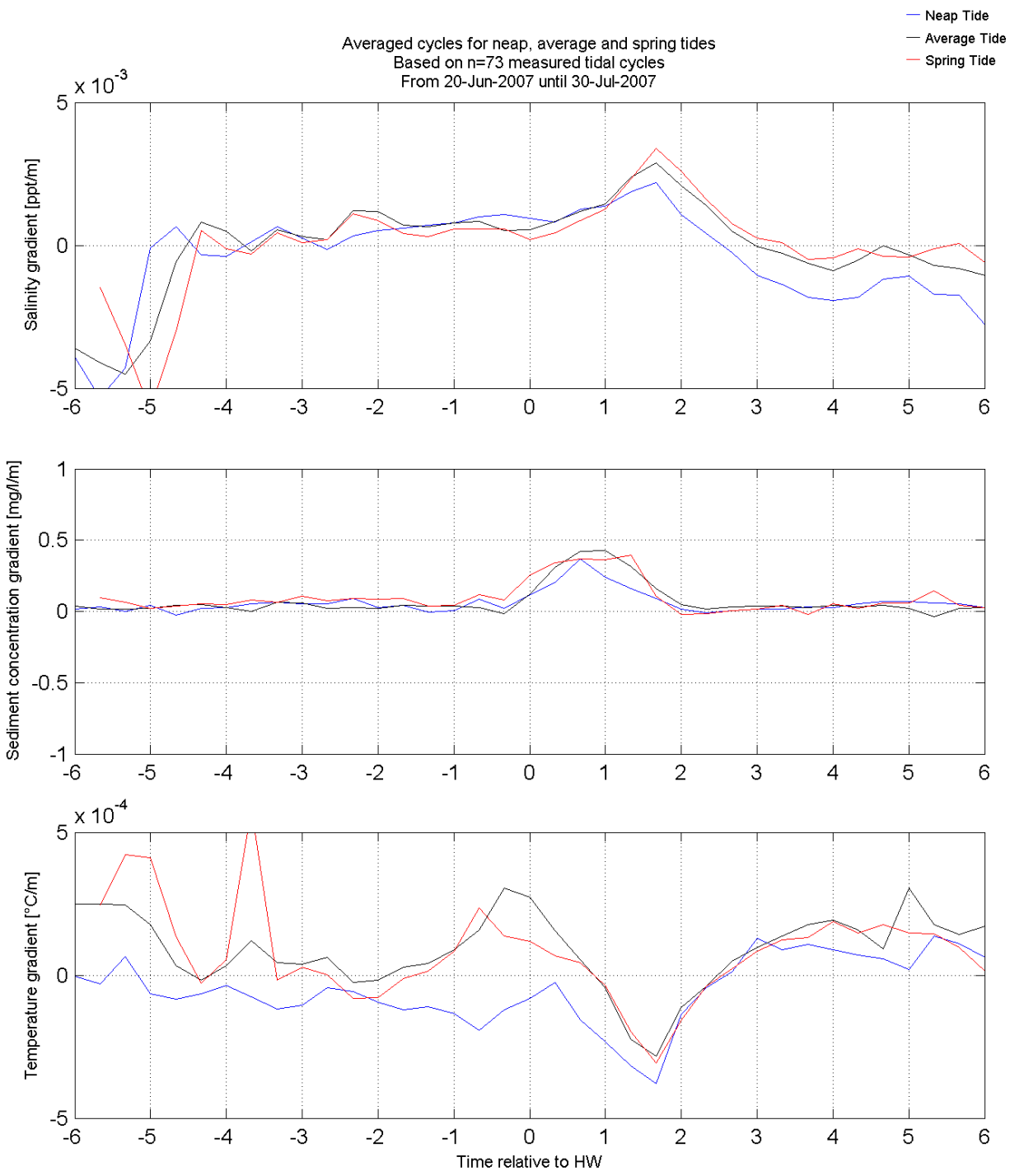
In association with :

I/RA/11283/07.092/MSA

D.2 Along-dock, cross-dock and vertical gradients

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS 3A
	Location: DGD-entrance



Horizontal gradient at -12m TAW =(N-ENTRANCE - S-ENTRANCE)/Δx

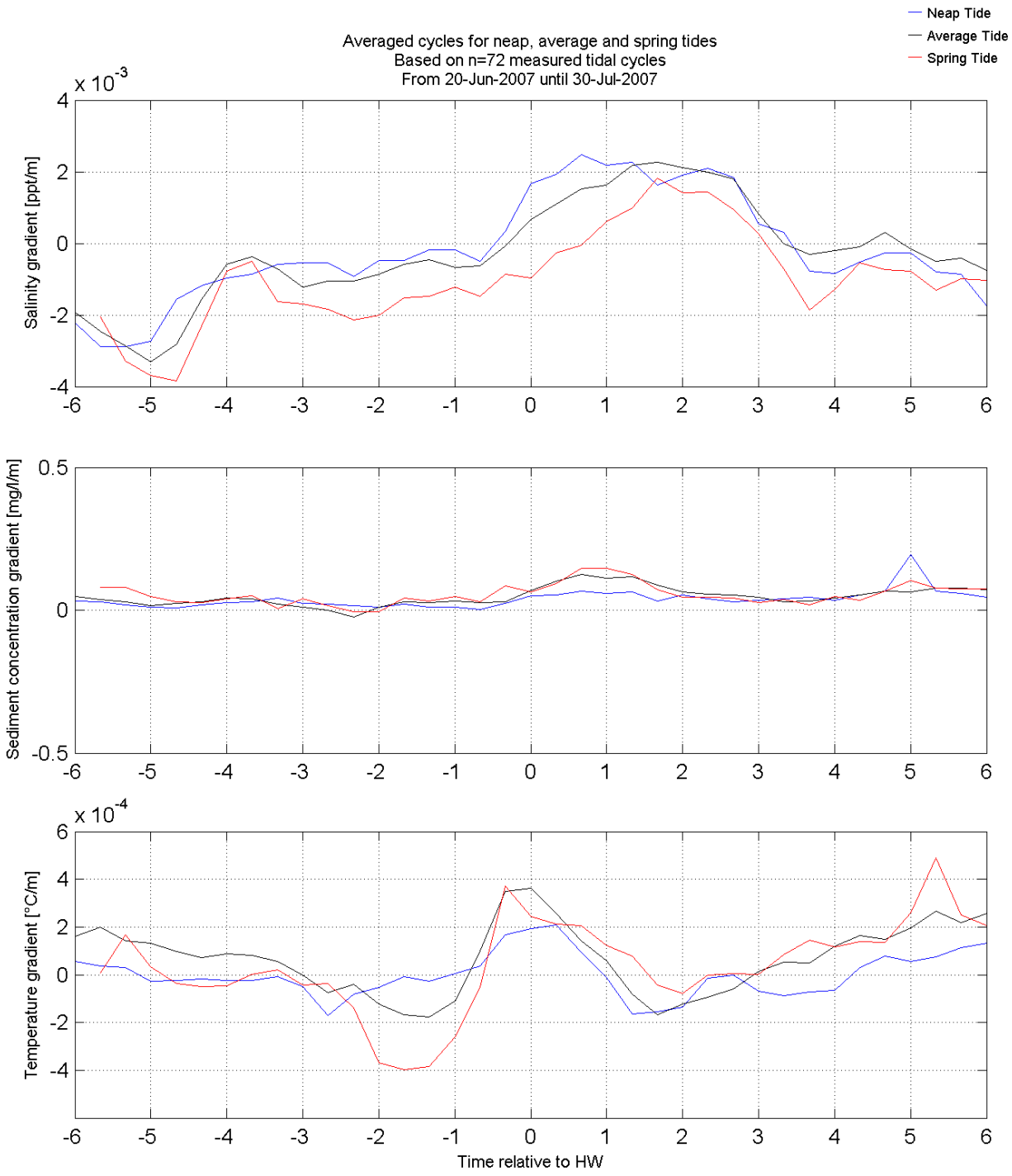
Data Processed by: IMDC

In association with : WL | delft hydraulics, GEMS International

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS 3A
	Location: DGD-entrance



Horizontal gradient at -2.2m TAW =(N-ENTRANCE - S-ENTRANCE)/Δx

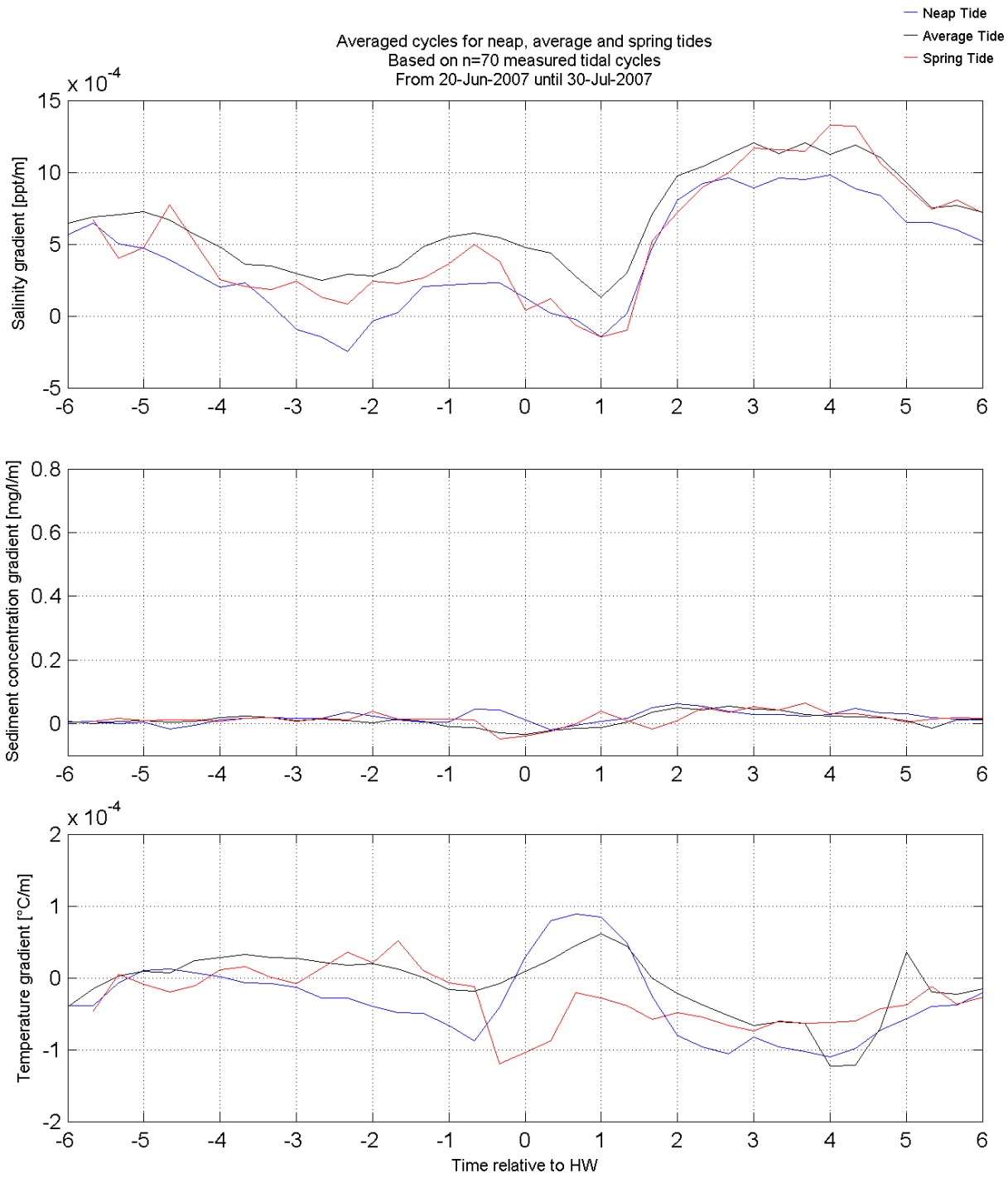
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS 3A
	Location: DGD-P&O (S)



Horizontal gradient at -12.6 m TAW =(S-BACK - S-ENTRANCE)/Δx

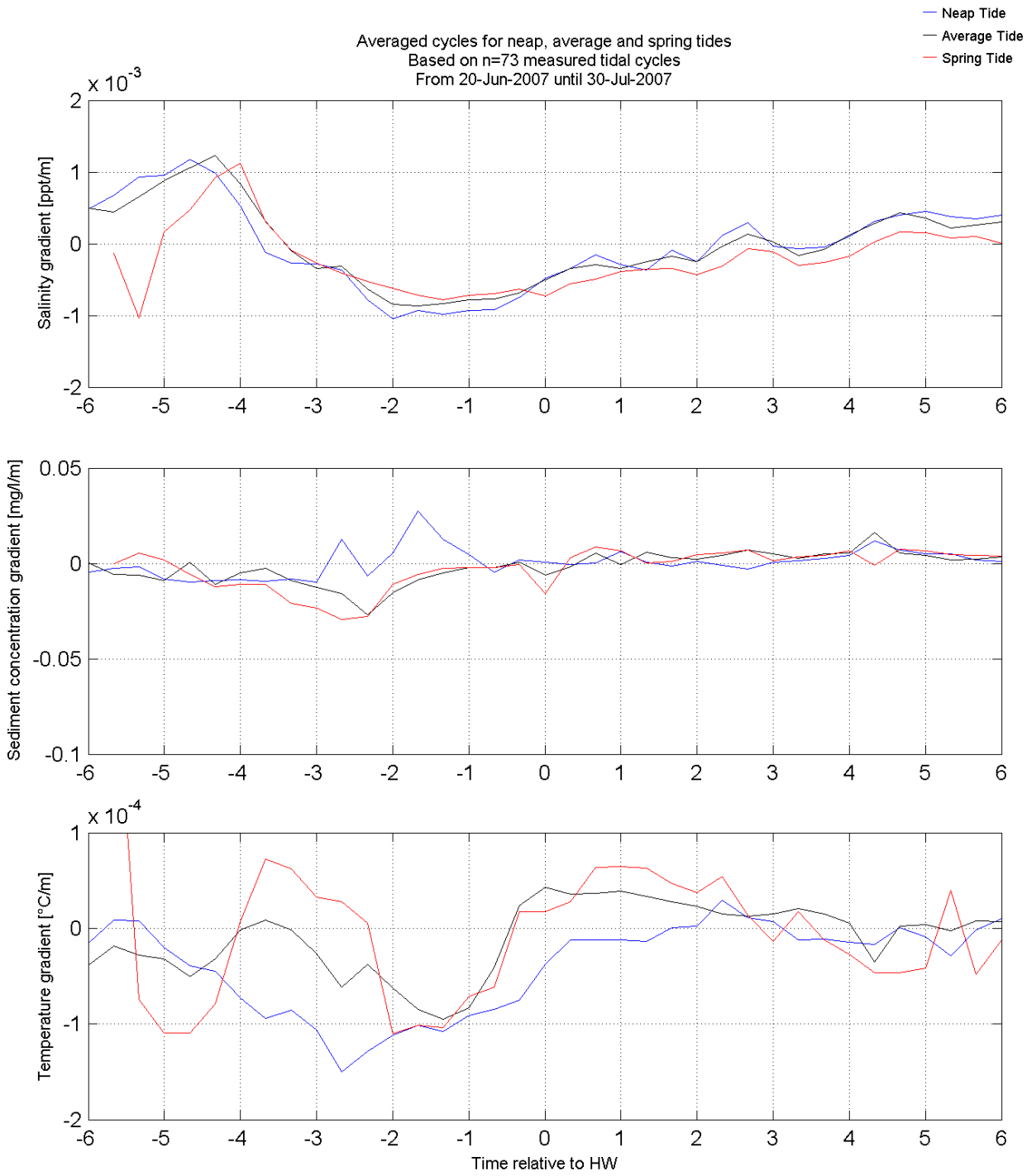
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS 3A
	Location: DGD-P&O (S)



Horizontal gradient at -2.4 m TAW =(S-BACK - S-ENTRANCE)/Δx

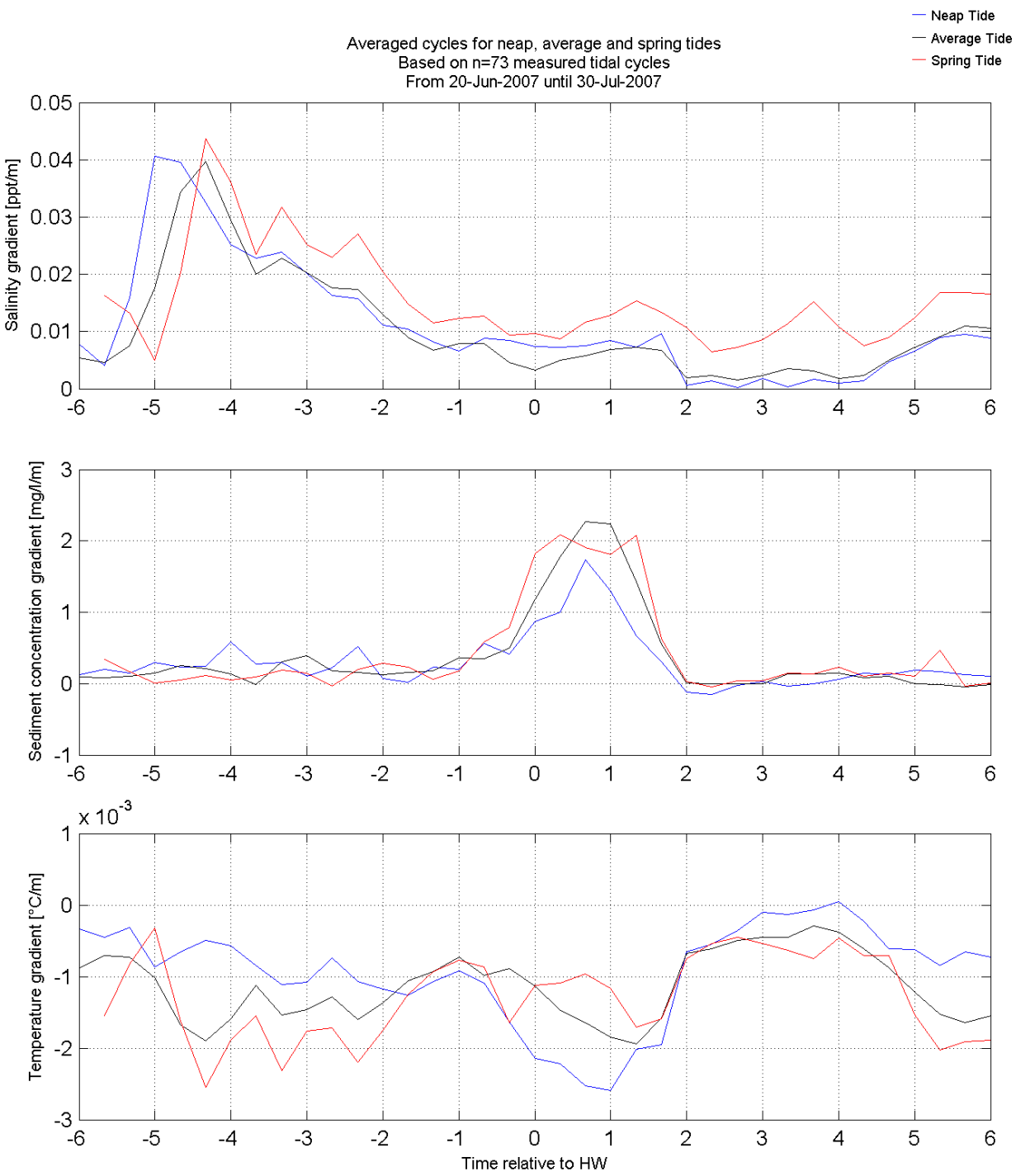
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS 3A
	Location: DGD-PSA (N-entrance)



Vertical gradient at N-ENTRANCE =(data(-13m) - data(-2m))/Δz

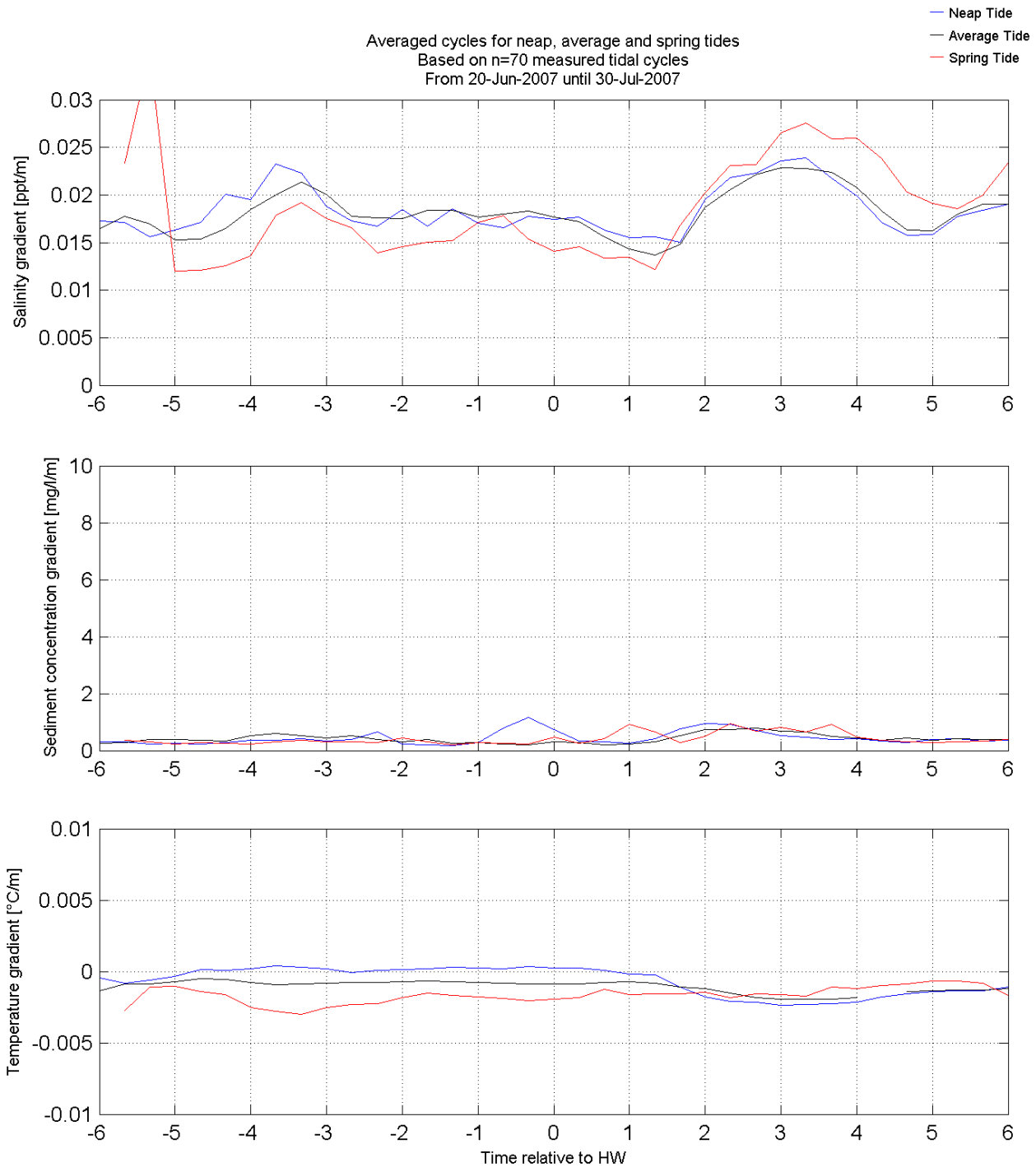
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS 3A
	Location: DGD-P&O1 (S-back)



Vertical gradient at S-BACK =(data(-12m) - data(-2m))/Δz

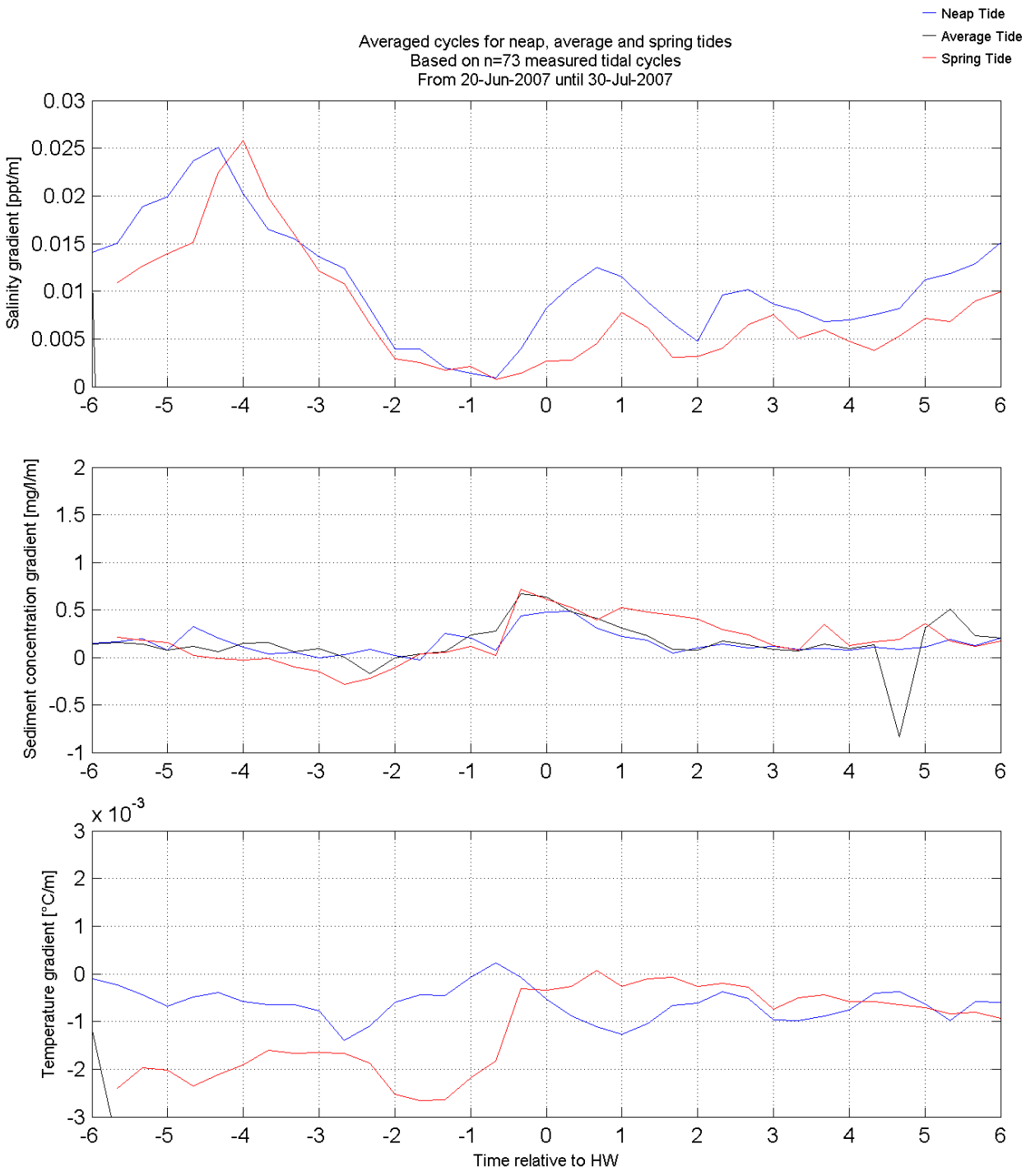
Data Processed by:

In association with :

I/RA/11283/07.092/MSA

Long Term Monitoring Siltation Deurganckdok

Summer 2007	OBS 3A
	Location: DGD-P&O2 (S-entrance)



Vertical gradient at S-ENTRANCE =(data(-13m) - data(-2m))/Δz

Data Processed by:

In association with :

I/RA/11283/07.092/MSA